Essays on market power and price strategy in the U.S. dairy industry

by

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B.S., University of Electronic Science and Technology of China, China, 2007
M.A., Guangdong University of Foreign Studies, China, 2009

AN ABSTRACT OF A DISSERTATION

submitted in partial fulfillment of the requirements for the degree

DOCTOR OF PHILOSOPHY

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Abstract

This dissertation constitutes two essays discussing the market power and price strategy in the dairy industry, which historically played an important role in the U.S. agriculture sector.

The first essay focuses on a merger case in the dairy industry. On April 1, 2009, Foremost Farms USA (referred to as Foremost Farms), a Wisconsin-based dairy producers' cooperative, sold its consumer products division, which included two dairy processing plants, to Dean Foods, and these plants produced distinct brands of milk. The United States Department of Justice (DOJ) expressed concern that this acquisition would have substantial anticompetitive effects in certain markets. Consistent with this view, in July 2011, the DOJ issued a final order requesting that Dean Foods divest one of the newly acquired plants. This essay empirically examines whether DOJ's concern, as well as its policy action, are supported by the data. The results suggest that, except for two package sizes of milk, Dean Foods jointly priced the newly acquired brands of milk along with its pre-existing milk brands, and such cooperative price-setting behavior is consistent with an anticompetitive effect. However, the magnitudes of the percentage increases in price-cost markups due to joint pricing are sufficiently small, suggesting that anticompetitive effects should not be of concern. In case of the divestiture period, we find that a subset of the products from the divested brand went back to being priced separately from Dean Food's milk products as required by DOJ's order. However, the magnitudes of the percentage decreases in price-cost markups are sufficiently small, suggesting that divestiture effects are negligible.

Consumers' perception of the marginal quality difference between organic and conventional products allow firms to charge a price premium associated with the perceived quality difference, the organic price premium. The organic price premium is effectively consumers' willingness to pay (WTP) for the organic attribute. The second essay addresses the question of

how the quantity of media coverage on organic dairy issues impacts the organic price premium for milk. We first use a theoretical model to illustrate how media information may influence the organic price premium. Our subsequent empirical analysis suggests, on average, consumers are willing to pay $1.19/gallon more for the organic attribute of milk, which corresponds to 19.07% of the mean price per gallon of organic milk. Second, we find evidence that the quantity of newspaper coverage on organic dairy issues significantly increases WTP for the organic feature of milk, but this impact follows an inverted-U curve with a diminishing marginal effect. Interestingly, TV and Radio news coverage of similar issues are not found to have a significant effect on WTP, which may be partly driven by survey evidence suggesting that consumers' main reason for listening to radio or watching TV is to be entertained rather than to be informed.

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Chapter 1- Competitive Conduct and Antitrust Policy Actions in the U.S. Dairy Industry: The Case of Dean Foods and Foremost Farms USA

1.1 Introduction

Dean Foods is the nation's largest fluid milk processor, operating 81 dairy plants in 35 U.S. states in 2008. On April 1, 2009, Foremost Farms USA (referred to as Foremost Farms), a Wisconsin-based dairy producers' cooperative, sold its consumer products division, which included two dairy processing plants to Dean Foods. These two processing plants are located in De Pere, Wisconsin and Waukesha, Wisconsin respectively. This acquisition cost of $35 million is a value that is less than the federal antitrust notification statute value; therefore, this merger was not reported beforehand to the federal antitrust authorities. The Department of Justice (DOJ), the states of Wisconsin, Illinois and Michigan, filed a civil antitrust suit on January 22, 2010 against Dean Foods in the U.S. District Court for Eastern Wisconsin, with the purpose to disassemble the acquisition. Because Dean Foods and Foremost Farms were the first and fourth largest milk processors in these areas, the complaint argued that this merger eliminated an aggressive competitor (Foremost Farms) of the sale of fluid milk against Dean Foods in northeastern Illinois, the Upper Peninsula of Michigan and Wisconsin. The complaint also reported the processed milk market share of Dean Foods within the region, approximately 57% prior to the acquisition. DOJ's complaint in this case also pointed out that the acquisition disrupted normal dairy competition, and increased the Herfindahl–Hirschman Index (HHI) by 1,127 points to 3,830. The acquisition resulted in an even larger increase in HHI within the relevant geographic area, especially in the

Upper Peninsula of Michigan, where HHI increased by 2,814 points to 7,510.[1] On July 29, 2011, the final judgment of this case required Dean Foods to divest Waukesha plant, and also required Dean Foods to notify DOJ of any future acquisition of milk processing operation if the value of the acquisition was $3 million or greater.

In the U.S., mergers are typically challenged under Section 7 of the Clayton Act, which prohibits transactions that may substantially lessen competition or create a monopoly. The primary objective of this paper is to empirically examine whether DOJ's concern, as well as its policy action in the case described above, are supported by the data. To achieve the primary objective, we use Information Resources Incorporation (IRI)[2] retail scanner data to estimate a structural econometric model of fluid milk demand and supply. A random coefficients logit model is used to capture the demand for milk. One of the major advantages of this model is that it imposes relatively few restrictions on obtaining estimates of own- and cross-price demand elasticities compared to the standard logit model. As is well-known in the empirical industrial organization literature, an important determinant of the market effects of a merger is the degree to which consumers perceive products of the firms that merge as substitutable. Since demand elasticities measure the degree to which consumers perceive products as substitutes, and merger effects crucially depend on this degree of product substitutability, it is important to use an empirical model that most accurately estimate demand elasticities.

Once demand parameter estimates are obtained, we specify several alternative oligopolistic competition supply models based on assumed Nash equilibrium price-setting behavior of firms, and several different firm-level joint pricing decisions of milk products. Conditional on the set of

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[1] The United States. Dept. of Justice. U.S. and Plaintiff v. Dean Foods Co., Jan 22, 2010, <https://www.justice.gov/atr/case-document/complaint-81>

[2] IRI Inc: A Chicago-based consulting firm that collects retail scanner data from major U.S. cities. We would like to thank IRI for making the data available. All estimates and analysis in this paper, based on data provided by IRI are by the authors and not by IRI.

demand parameter estimates, each alternate supply model corresponds to a distinct set of product-level price-cost margin estimates. The price-cost margin estimates are used to recover associated marginal cost estimates, and each set of marginal cost estimates are then regressed on the same set of exogenous cost-shifting variables to effectively produce several alternate supply model regression equations. Non-nested statistical test developed by Vuong (1989) is applied to assess which among the alternate supply models better approximate price-setting behavior during merger and divestiture periods, respectively. We refer to merger periods as the time periods in our data over which Dean Foods owned the two dairy processing plants acquired from Foremost Farms, while divestiture periods are the time periods subsequent to Dean Foods' divestiture of the Waukesha plant.

In the five IRI markets that might be affected by Dean Food's acquisition of the two dairy processing plants owned by Foremost Farms, we analyze four common package sizes of milk (16 ounces, 32 ounces, 0.5 gallon, and 1 gallon). Results of non-nested statistical tests of pairwise comparisons of the alternate supply models for milk products suggest that for two milk product package sizes, 16 ounces and 0.5 gallon, during the merger period Dean Foods jointly priced the new brands of milk products that it acquired from Foremost Farms with its pre-existing brands of milk products. The number of product observations in these two package sizes account for 70.5% of the total number of product observations in the dataset. Therefore, among a vast majority of product observations in the dataset, we find evidence of cooperative price-setting behavior across Dean Food's newly acquired and pre-existing brands of milk products, an empirical finding that is consistent with the presence of an anticompetitive effect associated with Dean Food's acquisition of the two dairy processing plants owned by Foremost Farms. In light of evidence supportive of the existence of an anticompetitive effect, we then use the supply models to compute the percentage decreases in product price-cost markups if the relevant brands of milk products were non-cooperatively priced instead of being cooperatively priced. The magnitudes of the percentage decreases in price-cost markups are typically small, suggesting that the anticompetitive effects are not sufficiently large to be of concern.

In the examined divestiture period, results of non-nested statistical tests of pairwise comparisons of the alternate supply models for milk products suggest that, consistent with the objective of DOJ's divestiture policy decision, a subset of the milk products that belong to the divested brand are priced separately from the brands of milk products owned by Dean Foods, a finding consistent with objective of the divestiture policy decision. However, under the counterfactual scenario in which the divested milk products are cooperatively priced with milk products owned by Dean Foods, we find that price-cost markups of milk products owned by Dean Foods will only increase by small amounts. Furthermore, predicted changes in price-cost markups for the divested products may either increase or decrease, but the absolute magnitudes of predicted markup changes on these products are also relatively small. As such, the predicted changes in price-cost markups are sufficiently small, suggesting that divestiture effects are negligible.

The remainder of this chapter is organized as follows. Section 1.2 briefly discusses relevant literature. Section 1.3 describes the fluid milk market and presents the available data in the five IRI markets that are possibly influenced by the acquisition. Section 1.4 outlines the empirical models on the demand side and supply side respectively. Section 1.5 presents and discusses the empirical results and Section 6 concludes with a brief summary of the findings.

1.2 Relevant Literature

An important determinant of the market effects of a merger is the degree to which consumers perceive products of the firms that merge as substitutable. As such, estimation of demand plays an important role in market power analysis. Relatively recent developments in using empirical discrete choice models to capture consumer demand for differentiated substitute products, especially variants of the logit model [e.g. see Berry (1994); and Berry, Levinsohn and Pakes (1995)], have substantially contributed to structural econometric analyses of market power, actual and proposed mergers [Nevo (2000, 2001)]. For example, Nevo (2000, 2001) estimates a random coefficients logit demand model of differentiated products to study the merger effects in the U.S. ready-to-eat cereal industry. Pinkse and Slade (2002) estimate the brand-level demand of beers from panel data, and then use the structural model to assess the effects of mergers on brand competition and pricing in the UK brewing industry. Raphael Thomadsen (2005) estimates a structural demand and supply model that accounts for market geography, and uses the estimated model to perform counterfactual experiments to analyze how ownership structures affect prices. Ivaldi and Verboven (2005) estimate a nested logit demand model of the European heavy truck market, and use the estimated demand parameters to compare several alternative market power tests in light of the Volvo/Scania merger. In line with the methodological framework of this literature, we also estimate the demand for differentiated products in the US dairy industry based on a random coefficients logit model, then use the estimated demand parameters in an analysis of price-setting behavior of US dairy firms in light of merger and divestiture events among a subset of the firms.

The supply side of our analysis also considers modeling vertical relationships between milk manufacturers and retailers, which positions our paper in a literature that studies price-setting behavior between firms that are vertically related. Cotterill and Dhar (2003) study the pricing strategies of vertically related firms, retailers and milk processors, in the Boston fluid milk market. The authors specify two game theoretic models, a model of coordination and a model of non-cooperative Nash behavior among vertically related firms, to capture the strategic interactions between retailers and milk processors. In case of the vertical coordination model, each retailer maximizes profits as if it owned and controlled milk processors, but in the vertical Nash model, processors and retailers non-cooperatively choose wholesale and retail prices to maximize their individual profits. Similar to the methodology in our paper, Villas-Boas (2007) analyzes several alternate oligopoly supply models distinguished by assumed vertical price-setting behavior between yogurt manufactures and yogurt retailers, and uses non-nested statistical tests to determine the best-fitting model among the different supply models.[3] Bonnet and Bouamra-Mechemache (2016) consider a model based on vertical linear contracting between milk processors and retailers in the French fluid milk market, and use this model to estimate how the value added created by an organic label is shared in a vertical chain among milk processors and retailers.

1.3 The Fluid Milk Industry and Data used in the Analysis

The fluid milk industry is characterized by increasing consolidation and concentration, which are likely driven by economies of size, technological change in manufacturing processes and plants, and the high concentration of retail chains. While these structural changes can lead to lower prices due to cost reduction from production efficiency, they can also lead to higher prices due to

[3] Also see Bonnet and Dubios (2010), Bonnet, Dubios and Villas-Boas (2013), Rey and Verge (2008) for a similar research methodology.

increases in market power.[4] As presented in Table 1.1, in 2008 the number of plants operated by the top 10 largest dairy processor and manufacturers ranges from 9 to 81 plants.

Table 1.1: Top Ten American Dairy Processors in 2008

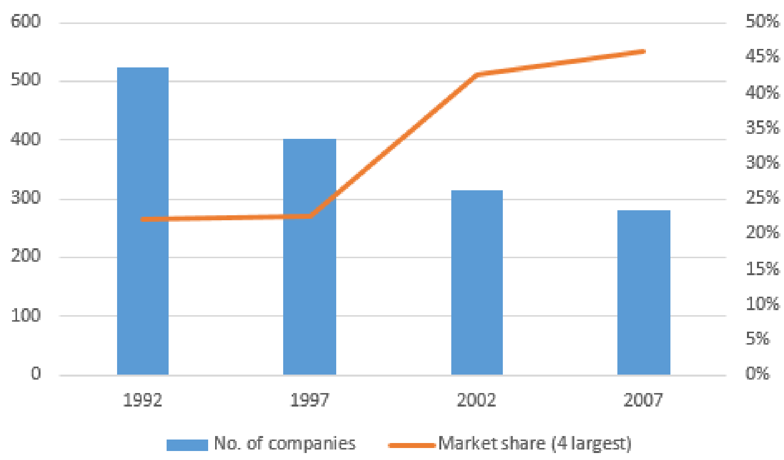
Rank	Company	Sales ($ million)	Number of Plants
1	Dean Foods Co.	12,454	81
2	Kraft Foods North America Inc.	4,800	16
3	Saputo Inc.	4,390	45
4	Land O' Lake Inc.	4,136	9
5	Schreiber Food Inc.	3,500	18
6	Prairie Farms Dairy	2,924	20
7	Agropur Cooperative	2,800	26
8	Kroger Co. Dairy Operation	2,500	19
9	Leprino Food Co.	2,500	9
10	Darigold Inc.	2,200	11

Source: Dairy Foods, https://www.dairyfoods.com/ext/resources/DF/Home/Files/PDFs/archives/d/df0809Dairy-100-table.pdf

Based on the U.S. Census Bureau data summarized in Figure 1, the number of companies in the fluid milk processing has declined substantially since 1992, and this decline is accompanied by a striking increase in concentration among fluid milk processing firms. Using the largest four milk processing firms' share of shipments in the fluid milk industry to construct a time series of four-firm concentration ratios, beginning in year 1997 a sharp increase in the four-firm concentration ratio is evident from Figure 1. The sharp increase in the four-firm concentration ratio is largely driven by notable mergers and acquisitions involving Dean Foods. For example, on Dec 21, 2001, Dean Foods and Suiza Foods (the top two dairy processors) completed their merger. Subsequently, Land O' Lakes dairy cooperative sold its fluid milk plants to Dean Foods in July 2002. In 2004 Dean Foods acquires Horizon Organic Holding Corporation, and in April 2009 Foremost Farms USA sold two milk plants to Dean Foods.

[4] GAO-05-50: Information on Milk Prices, Factors Affecting Prices, and Dairy Policy Options

Figure 1.1: Fluid Milk Processors



Source: Number of companies and the market share data are obtained from U.S. Census Bureau (1992-2007)

This study uses Information Resources Inc. (IRI) retail point-of-sale scanner data. Information Resources Inc. is a Chicago marketing firm that uses scanning devices to collect point-of-sale retail data across 50 geographically distinct markets located in metropolitan and rural areas of the United States. Dairy is one of the 30 product categories covered by IRI data, and is the product category of interest for this research. The point-of-sale data are weekly and compiled according to Universal Product Code (UPC) transactions in retail stores. Four common package sizes of fluid milk products are included in the analysis: (i) one gallon; (ii) half gallon; (iii) 32 ounces; and (iv) 16 ounces. Considering the periods surrounding the merger and divestiture events stated in the DOJ's documents, the time period examined in this paper lies from January 2006 to December 2012.

We define a product as the unique combination of non-price characteristics and retail store, where the measured non-price characteristics are: brands, type of milk, flavor, fat content, organic versus non-organic classification, and package type materials. Milk consumption is measured by monthly aggregate quantity of each uniquely defined product purchased in a retail store located in one of the IRI markets. For each product, an average price is computed as the average revenue from sales during the relevant month (in dollars per gallon). Summary statistics of these data are reported in Table 1.2.

Electricity is intensively used by dairy processors to drive machines and for cold storage, and therefore is a major input in fluid milk production. As such, to capture a measurable determinant of production cost, we collected state level industrial electricity price data from the U.S. Energy Information Administration. All price data are deflated by the consumer price index (index base year Jan 2008 =100).

Several non-price product characteristic zero-one dummy variables were constructed to facilitate the empirical analysis. Table 1.2 reports summary statistics on product characteristic variables used in the empirical analysis. One non-price product characteristic considered is milk type, which correspond to the following five categories of milk: (i) full lactose; (ii) reduced lactose; (iii) full lactose with acidophilus; (iv) soy milk; and (v) almond milk. Lactose is the major carbohydrate found naturally in the milk of most animal species. Milk processing firms often make the decision to put a subset of their fluid milk through a processing procedure that reduces the amount of lactose naturally present in milk in order to obtain reduced lactose milk products. Acidophilus milk is regular milk enriched with acidophilus, a strain of healthy bacteria. Although acidophilus has been used to treat or prevent a wide range of ailments, including yeast infections, diarrhea, irritable bowel syndrome, lactose intolerance, intestinal problems, and urinary tract infections, a subset of the health benefit claims of consuming acidophilus have not been scientifically proven. Soy milk is a plant-based drink produced by soaking and grinding soybeans, boiling the mixture, and filtering out remaining particulates. Similar to soy milk, almond milk is a plant-based drink often consumed by those who are lactose-intolerant and others who wish to avoid dairy products. Almond milk is manufactured from the edible and widely cultivated seed of the almond tree.

In the package size of 16 ounces, there is only full lactose milk, while the 32 ounces package size has the following three types of milk: (*i*) full lactose, which comprises 75.93% of the fluid milk in this package size; (*ii*) reduced lactose, which comprises 10.34% of the fluid milk in this package size; and (*iii*) soy milk, which comprises 13.23% of the fluid milk in this package size. There are five types of milk in the 0.5 gallon package size, where full lactose milk accounts for 46.91%, followed by soy milk (27.68%), reduced lactose milk (17.48%), almond milk (7.05%) and full lactose milk with acidophilus (0.88%). The 1 gallon package size has two types of milk: full lactose milk accounts for 92.55%, and soy milk 7.45%.

There are four milk flavor categories in the dataset: (*i*) regular white; (*ii*) vanilla; (*iii*) original; and (*iv*) plain. The 16 ounces package size only has one milk flavor, which is regular white milk. Both 32 ounces and 0.5 gallon package sizes have four milk flavor categories, among which the flavor of regular white accounts for the largest share, followed by vanilla, original and plain. There are three categories of milk flavor in the 1 gallon package size, 92.55% of which is the regular white milk flavor, followed by the flavor categories of vanilla (1.28%) and original (6.17%).

We classify the fat content of dairy milk into two categories, whole milk and non-whole milk. In addition, we put plant-based milk products, such as soy milk and almond milk, into the fat content category of non-whole milk. Among the 16 ounces package size 40.66% of the fluid milk products are whole milk, while among the 32 ounces package size fluid milk products 34.32% are whole milk. Among the 0.5 gallon package size 24.74% of the fluid milk products are whole milk, while 44.36% of the fluid milk products are whole milk among the 1 gallon package size.

Table 1.2: Summary Statistics

	Size 1 (16 ounces container)					Size 2 (32 ounces container)					Size 3 (0.5 gallon container)					Size 4 (1 gallon container)				
Description	Mean	Standard deviation	Min	Max	Obs	Mean	Standard deviation	Min	Max	Obs	Mean	Standard deviation	Min	Max	Obs	Mean	Standard deviation	Min	Max	Obs
Real Milk Price (dollars per gallon)[1]	8.7442	1.3784	3.6775	15.6715	21,114	6.8082	1.6500	1.9321	18.4454	29,901	6.5012	1.4850	1.2917	13.2329	158,439	4.0205	1.4562	0.9786	10.3600	45,267
Mean Personal Income(dollars per year)	36,789	3,543.6	24,806.1	41,743.1	21,114	35,840.59	3,912.5	24,806.1	41,743.1	29,901	36,296.74	3,632.7	24,806.1	41,743.7	158,439	36,042.13	3823.29	24806.1	41743.1	45,267
IRI Market Population (per year)	6,040,018	3,393,889	96,527	9,108,058	21,114	5,844,167	3,529,616	96,527	9,108,058	29,901	5,595,475	3,479,540	96,527	9,108,058	158,439	5,239,710	3,513,091	96,527	9,108,058	45,267
Age	50.0524	16.5273	15	95	21,114	47.8215	17.3157	15	95	29,901	44.3298	19.5273	15	95	158,439	45.2451	18.0210	15	95	45,267
Real Electricity Price (cents per kWh)	6.1135	0.8647	4.2471	7.8745	21,114	6.1566	0.7958	4.2471	7.8745	29,901	6.1729	0.8204	4.2471	7.8745	158,439	6.1889	0.8065	4.2471	7.8745	45,267
Milk Type Dummy Variables:																				
Full Lactose Milk	1	0	1	1	21,114	0.7593	0.4275	0	1	29,901	0.4691	0.4990	0	1	158,439	0.9255	0.2626	0	1	45,267
Reduced Lactose Milk[2]	-	-	-	-	-	0.1084	0.3108	0	1	29,901	0.1748	0.3798	0	1	158,439	-	-	-	-	-
Full Lactose Milk with Acidophilus	-	-	-	-	-	-	-	-	-	-	0.0088	0.0937	0	1	158,439	-	-	-	-	-
Soy Milk	-	-	-	-	-	0.1323	0.3388	0	1	29,901	0.2768	0.4474	0	1	158,439	0.0745	0.2626	0	1	45,267
Almond Milk	-	-	-	-	-	-	-	-	-	-	0.0705	0.2559	0	1	158,439	-	-	-	-	-
Flavor Type Dummy Variables:																				
Regular White	0.9339	0.2484	0	1	21,114	0.8634	0.3434	0	1	29,901	0.6271	0.4836	0	1	158,439	0.9255	0.2626	0	1	45,267
Vanilla	0.0661	0.2484	0	1	21,114	0.0734	0.2608	0	1	29,901	0.1623	0.3687	0	1	158,439	0.0128	0.1125	0	1	45,267
Original	-	-	-	-	-	0.0628	0.2426	0	1	29,901	0.1214	0.3266	0	1	158,439	0.0617	0.2406	0	1	45,267
Plain	-	-	-	-	-	0.0004	0.0200	0	1	29,901	0.0892	0.2849	0	1	158,439	-	-	-	-	-
Fat Content Dummy (=1 if whole milk)	0.4066	0.4912	0	1	21,114	0.3432	0.4748	0	1	29,901	0.2474	0.4315	0	1	158,439	0.4436	0.4968	0	1	45,267
Organic milk Dummy (=1 if organic)	-	-	-	-	-	-	-	-	-	-	0.2277	0.4193	0	1	158,439	0.2008	0.4006	0	1	45,267
Package Type Dummy Variables:																				
Package of Carton	0.0612	0.2397	0	1	21,114	0.4943	0.5000	0	1	29,901	0.7216	0.4482	0	1	158,439	0.0753	0.2639	0	1	45,267
Package of Plastic	0.9388	0.2397	0	1	21,114	0.5057	0.5000	0	1	29,901	0.2197	0.4140	0	1	158,439	0.9237	0.2655	0	1	45,267
Package of Glass	-	-	-	-	-	-	-	-	-	-	0.0587	0.2352	0	1	158,439	0.0010	0.0322	0	1	45,267

1. All price data are deflated by the consumer price index (CPI) (index base period is Jan, 2008 =100).

2. Reduced lactose milk includes the lactose-free milk

There is no single variable in the IRI dataset that is constructed with the purpose of identifying milk products that are organic. As such, in order to identify organic milk products in the data we examine variables with various descriptive information on each product and classify the relevant product as organic if: (*i*) the brand description includes the word "organic"; or (*ii*) the process description includes the phrases, "organic", "organic homogenized", "organic pasteurized", "organic ultra-pasteurized", or "organic pasteurized and homogenized". In addition, there are a few dairy companies that produce organic products, but neither the descriptions of their brands nor their process include the term "organic". For example, Castle Rock, Stonyfiled Farm, and Stremick Heritage are firms that focus on organic dairy production, therefore, we treat the products from these three firms as organic products. Based on this organic classification methodology we then constructed a zero-one dummy variable that takes a value of one only when the relevant product is classified as "organic". Among fluid milk products in 0.5 gallon and 1 gallon package sizes, organic fluid milk products comprise 22.8% and 20.08%, respectively. There are no organic fluid milk products among fluid milk products in package sizes 16 ounces and 32 ounces.

Since materials used for making milk containers differ, we create a set of dummy variables to capture the range of container materials. In the 16 ounces package size dataset, 6.12% of the package containers are made from carton, and 93.88% are made from plastic. In the 32 ounces package size dataset, 49.43% of the package containers are made from carton, and 50.57% use plastic packaging. Among milk products in 0.5 gallon package size, carton packaging accounts for 72.16%, followed by plastic packaging (21.97%), and 0.059% glass packaging (0.059%). Among milk products in 1 gallon package size, plastic packaging accounts for 92.37%, while carton and glass packaging account for only 7.53% and 0.10%, respectively.

We supplement the IRI scanner data on milk product sales with market-specific consumer demographic information, such as income and age. These demographic data are drawn from Public Use Microdata Sample database (PUMS).

1.4 The Empirical Models

1.4.1 Demand for Differentiated Milk Products

With the data presented in the previous, we use a random coefficients logit model to estimate demand (Berry, Levinsohn and Pakes 1995, Nevo 2000 and 2001). Suppose consumer i is faced with the decision to either choose between *J* differentiated milk products sold in market *t*, where the products are indexed by *j* = 1, 2 …, *J*, or choose to not purchase any milk product, and this option is represented by *j* = 0. In making this discrete choice decision, we assume the consumer chooses the option that yields the highest satisfaction, i.e., in making the decision the consumer effectively solves the following utility maximization problem:

$$\max_{j\in\{0,1,2,\ldots,J\}}\{U_{ijt} = X_{jt}\beta_i + \alpha_i p_{jt} + \rho_{year} + \tau_{month} + \gamma_{market} + \xi_{jt} + \varepsilon_{ijt}\} \qquad (1.1)$$

where U_{ijt} is the conditional indirect utility consumer i obtains from choosing option j in market *t*; X_{jt} is a vector that includes observed non-price product characteristics; and β_i is the vector of consumer-specific taste parameters associated with observed product characteristics; ρ_{year}, τ_{month} and γ_{market} represent fixed effect controls for year, month, and geographic location of IRI market respectively; p_{jt} is the price of product *j* in market *t*, and α_i represents the individual-specific marginal utility of price; ξ_{jt} represents product characteristics that are unobserved by econometricians but observed by consumers; ε_{ijt} represents the random component of utility that is assumed independent and identically distributed across consumers, products and markets.

The random coefficients α_i and β_i are allowed to vary across consumers according to:

$$\begin{pmatrix} \beta_i \\ \alpha_i \end{pmatrix} = \begin{pmatrix} \beta \\ \alpha \end{pmatrix} + \Gamma D_i + \Sigma v_i \tag{1.2}$$

where D_i is an m-dimensional column vector of demographic variables (assuming there are m distinct demographic variables), and each demographic variable enters the vector in the form of deviation of individual i's demographic variable from the mean of the market sample of individuals; Γ is a L-by-m dimension matrix of parameters (L is the number of random taste parameters in $\begin{pmatrix} \beta_i \\ \alpha_i \end{pmatrix}$), where the parameters measure how taste characteristics vary with demographics; v_i is a L-dimensional column vector of unobserved shocks to consumer taste for respective product characteristics; and Σ is a L-by-L diagonal matrix, where elements on the main diagonal are parameters that measure variation in taste due to the random shocks in v_i.

In the demand estimation, demographic variables in D_i are income and age. Since demographic variables in D_i are expressed in deviations from their respective means, the mean of each variable in D_i is zero. Following Nevo (2000), we assume that v_i has a standard multivariate normal distribution, $v_i \sim N(0, I)$. Therefore, the previously described properties of D_i and v_i imply that the mean of $\begin{pmatrix} \beta_i \\ \alpha_i \end{pmatrix}$ is $\begin{pmatrix} \beta \\ \alpha \end{pmatrix}$ and the variance is equal to the square of the elements on the main diagonal of Σ.

Substituting equation (1.2) into the indirect utility function shown in equation (1.1) allows us to re-write the indirect utility function as follows:

$$U_{ijt} = \delta_{jt}\left(x_{jt}, p_{jt}, \xi_{jt}; \theta_1\right) + \mu_{ijt}\left(x_{jt}, p_{jt}, D_i, v_i; \theta_2\right) + \varepsilon_{ijt} \tag{1.3}$$

where $\theta_1 = \left(\beta, \alpha, \rho_{year}, \tau_{month}, \gamma_{market}\right)$, $\theta_2 = (\Gamma, \Sigma)$ and

$$\delta_{jt} = X_{jt}\beta + \alpha p_{jt} + \rho_{year} + \tau_{month} + \gamma_{market} + \xi_{jt} \tag{1.4}$$

$$\mu_{ijt} = \left[x_{jt},\ p_{jt}\right](\Gamma D_i + \Sigma v_i) \tag{1.5}$$

Since the mean of μ_{ijt} and the mean of ε_{ijt} across consumers both equal to zero, then equation (1.3) reveals that the mean of U_{ijt} across consumers is δ_{jt}. Therefore, the mean utility across consumers who purchase product j is δ_{jt}, while μ_{ijt} and ε_{ijt} capture consumer i's deviation from the mean utility.

As described above, we allow consumers the option not to choose one of the differentiated milk products, and this option is represented by $j = 0$. This option is often referred to as the outside good, or outside option. Following much of the literature, we assume that the mean utility obtained from choosing the outside good is normalized to be zero and constant over time, i.e., the indirect utility from this outside option is $U_{i0t} = \varepsilon_{i0t} = 0$.

Assuming that ε_{ijt} is independent and identically distributed with an extreme value type I density, the predicted market share of product j in market t is given by:

$$s_{jt}(x_{jt}, p_{jt}, \xi_{jt}; \theta_1, \theta_2) = \int_{A_{jt}} \left(\frac{\exp(\delta_{jt}+\mu_{ijt})}{1+\sum_{l=1}^{J} \exp(\delta_{lt}+\mu_{ilt})} \right) d\hat{F}(D) d\Phi(v_i) \tag{1.6}$$

where A_{jt} represents the set of consumers who choose product j in market t, $\hat{F}(D)$ is the empirical distribution of demographic variables (income, age, etc.) in the market. $\Phi(\cdot)$ is the standard normal distribution function. Since there is no closed-form solution for the integral in equation (1.6), this integral must be approximated numerically using random draws from $\hat{F}(D)$ and $\Phi(\cdot)$. We use 300 random draws from $\hat{F}(\cdot)$ and $\Phi(\cdot)$ for the numerical approximation of $s_{jt}(\cdot)$. As previously stated, consumer demographic information, such as income and age, are randomly drawn from Public Use Microdata Sample database (PUMS).

Based on the discrete choice model described above, the demand for product j in market t is simply given by:

$$d_{jt} = s_{jt}(x_{jt}, p_{jt}, \xi_{jt}; \Theta) \times M_t \tag{1.7}$$

where $\Theta = (\theta_1, \theta_2)$ is the vector of demand parameters to be estimated, and M_t is a measure of the potential market size of market t.

We construct the potential market size measure, M_t, in each market using the following procedure. First, we obtained data on annual per capita dairy fluid milk consumption from United States Department of Agriculture Economic Research Service (USDA ERS).[5] Since USDA ERS per capita dairy fluid milk consumption data are measured in liquid pounds, we converted the unit of measurement of these data to gallons, and divide by 12 to obtain average monthly per capita consumption of dairy fluid milk in gallons. Second, even though we were not able to obtain per capita consumption of soy milk directly, we sourced data on annual total sales of soy milk in gallons,[6] and divide these unit sales data by population size to obtain average annual per capita soy milk consumption. We then convert these average annual per capita soy milk consumption data to average monthly per capita soy milk consumption. This method is also used to compute monthly per capita consumption of almond milk.[7] Third, monthly per capita fluid milk (dairy, soy, and almond) consumption is obtained by summing monthly per capita consumption of dairy, soy, and almond milk. Last, potential market size measure, M_t, in each market is computed by using the population size of the relevant geographic market multiplied by monthly per capita fluid milk consumption.

Using the random coefficients logit model to estimate the demand not only allows for consumer heterogeneity, but also provides a more flexible pattern of consumption substitution between products. The own- and cross-elasticity of the market demand d_{jt} are given by

$$\eta_{jkt} = \frac{\partial sd_{jt}}{\partial p_{kt}} * \frac{p_{kt}}{d_{jt}} = \begin{cases} -\frac{p_{jt}}{d_{jt}} \int \alpha_i \, s_{ijt}(1 - s_{ijt}) d\hat{F}(D)\phi(v_i) dv_i & if\ j = k \\ \frac{p_{kt}}{d_{jt}} \int \alpha_i \, s_{ijt} s_{ikt} d\hat{F}(D)\phi(v_i) dv_i & otherwise \end{cases} \tag{1.8}$$

where $s_{ijt} = \frac{\exp(\delta_{jt}+\mu_{ijt})}{1+\sum_{l=1}^{J}\exp(\delta_{lt}+\mu_{ilt})}$ is the probability of consumer i purchasing product j. Each consumer has different price sensitivity, which will be averaged to a mean price sensitivity

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[5] https://www.ers.usda.gov/data-products/dairy-data/
[6] https://www.statista.com/statistics/552967/us-soy-milk-sales/
[7] The sales data of almond milk is only available from year 2008. As such, we compute the monthly per capita consumption of almond milk from 2008 to 2012.

using s_{ijt} as weights. The cross-price elasticities are driven by product characteristics and consumers' heterogeneity.

1.4.2 Demand Estimation and Instruments

Parameters of the demand model are estimated using Methods of Simulated Moments (MSM) algorithm outlined in Nevo (2000). We construct the MSM estimator by using instrumental variables that are orthogonal to product characteristics captured in ξ_{jt}. As previously stated, product characteristics captured in ξ_{jt} are unobserved to us but observed by firms and consumers. Instrumental variables for the product price of milk are needed because it is likely that ξ_{jt} is correlated with milk price.

In the mean utility function (equation (1.4)), ξ_{jt} represents product characteristics such as consumer brand loyalty, firm promotional activities, the shelf display of milk products in retail stores, etc., which are observed by the firms and consumers but unobserved by the econometrician. Therefore, the price of product j in market t (p_{jt}) is correlated with ξ_{jt}. The variables used to instrument milk price are state-level electricity price for the industrial sector interacted with milk brand dummies. It is reasonable to assume that an input price such as electricity price is uncorrelated with ξ_{jt}, but highly correlated with milk price. For example, the consumer brand loyalty is most likely to be uncorrelated with the state-level electricity price, but changes in the price of electricity are likely to influence fluid milk prices. In fact, in year 2006 the electricity consumption in dairy industry accounted for nearly 13% of the entire food industry electricity usage (U.S. DOE 2006b). The monthly state-level electricity price for the industrial sector are collected from U.S. Energy Information Administration. We choose the monthly state-level industrial electricity price instead of national average electricity price because the industrial electricity price vary across states, and such variation potentially helps with identification.

The underlying intuition to interact the electricity price with brand dummies is to allow this input price to influence the production cost of each brand differently. Electricity price is likely to have differential impacts on production costs across milk brands when there is variation in the intensities with which the milk brands use electricity. For example, the brand "lactaid" focus on reduced lactose dairy milk, which is likely to consume more electricity than processing regular full lactose dairy milk. It is also known that the shelf life of organic milk is longer than conventional milk because organic milk usually undergoes ultrahigh temperature (UHT) processing or treatment, and conventional milk typically requires a standard preservation process. UHT requires higher electricity consumption, as such, electricity usage required by the production process is different across organic milk brands and conventional milk brands. Therefore, the electricity consumption is likely different between organic milk brands such as "Horizon organic" and conventional milk brands such as "Deans". Yet another example in which electricity usage required by the production process likely differ across various milk brand products is based on the fat content present in the final milk product.

1.4.3 Alternative Supply Models

The primary objective of this paper is to empirically examine the importance of DOJ's anticompetitive concern of Dean Foods' acquisition of two milk-processing plants owned by Foremost Farms, as well as DOJ's final order requiring that Dean Foods divest one of the newly acquired plants. The general empirical strategy is to use a non-nested statistical test to compare equilibrium price-setting behavior across the alternative supply models to investigate which among the supply models better fit the available data during the merger and divestiture periods respectively.

We assume that manufacturers and retailers set their prices sequentially, i.e., manufacturers first set the wholesale price p_j^w in Bertrand Nash fashion, and then retailers follow to set retail price p_j also in Bertrand Nash fashion. Consistent with using backward induction for solving the subgame perfect equilibrium in a sequential strategy choice game, we begin by describing the optimizing price-setting behavior of the retailers, then we describe the optimal price-setting behavior of the manufacturers.

Suppose there are R retailers, and retailers are indexed by $= 1,2, \dots, R$. Let S_r be the subset of the J products that are sold by retailer r. We assume that each retailer r maximizes its profit by appropriately setting retail price levels for the set of products that belong to S_r, i.e., retailer r solves the following optimization problem:

$$\max_{p_j \, \forall j \in S_r} \Pi_r = \max_{p_j \forall j \in S_r} \left[\sum_{j \in S_r} \left(p_j - p_j^w - mc_j^r \right) * d_j(p) - C_r \right] \tag{1.9}$$

where $d_j = M * s_j(p, \xi, \Theta)$ based on the previously described demand model; p_j^w is the wholesale price that retailer r pays to obtain product j from the manufacturer; mc_j^r is the marginal cost that retailer r incurs in providing product j to consumers; and C_r is the fixed cost of retailing incurred by retailer r. Market subscripts are suppressed in profit functions and the subsequent equations only for notional convenience. In an Nash equilibrium, retail price p_j of any product j sold by retailer r must satisfy the following first-order conditions:

$$s_j(p, \xi, \Theta) + \sum_{k \in S_r} (p_k - p_k^w - mc_k^r) \frac{\partial s_k(p, \xi, \Theta)}{\partial p_j} = 0 \qquad for\ j \in S_r \tag{1.10}$$

A couple more definitions will allow us to use matrix notations to express the set of first-order conditions that follow from profit maximizing price-setting behavior. First, let T^R be a $J \times J$ matrix of appropriately positioned zeros and ones based on the product ownership structure across retailers. In particular, let element T_{kl}^R in matrix T^R be defined as follows:

$$T_{kl}^R = \begin{cases} 1, & if \ \exists \ r : \{k, l\} \subset S_r \\ 0, & otherwise \end{cases}$$

that is, the element in row k and column l of matrix T^R is equal to one if there exists a retailer r that sells both product k and product l, otherwise element T_{kl}^R is equal to zero. The way in which matrix T^R is used in subsequent analyses; this matrix effectively determines which sets of products retailers jointly price. Second, let Δ^R be a $J \times J$ matrix of first-order derivatives of product market shares with respect to retail prices, where element $\Delta_{kl}^R = \frac{\partial s_k(p,\xi,\Theta)}{\partial p_l}$, and matrix Δ^R can be expressed as:

$$\Delta^R = \begin{pmatrix} \dfrac{\partial s_1}{\partial p_1} & \cdots & \dfrac{\partial s_J}{\partial p_1} \\ \vdots & \ddots & \vdots \\ \dfrac{\partial s_1}{\partial p_J} & \cdots & \dfrac{\partial s_J}{\partial p_J} \end{pmatrix}$$

The set of first-order conditions that follow from profit maximizing price-setting behavior of retailers can be written in matrix notation as follows:

$$s(p) + (T^R * \Delta^R) \times (p - p^w - mc^r) = 0 \qquad (1.11)$$

where $(T^R * \Delta^R)$ is an element-by-element multiplication of the two matrices; $s(\cdot)$, p, p^w, and mc^r are $J \times 1$ vectors of predicted product shares, retail prices, wholesale prices, and retailers' marginal costs, respectively. The first-order condition in equation (1.11) can be re-arranged to obtain retailers' product-level markups as follows:

$$p - p^w - mc^r = -(T^R * \Delta^R)^{-1} \times s(p) = markup^R(p, \xi; \Theta, T^R) \qquad (1.12)$$

Note that product-level retail markups are a function of demand-side variables and parameter estimates, as well as the product ownership structure matrix across retailers, T^R. As such, with demand parameter estimates in hand, $\widehat{\Theta}$, and a given structure for matrix T^R, the right-hand-side of equation (1.12) allows us to compute product-level retail markups.

We now describe optimal wholesale price-setting behavior of the manufacturers. Suppose there are F manufacturers. Let $f = 1,2, \dots, F$ index manufacturers and $\mathcal{F}_f$ be the subset of the J products that are produced by manufacturer f. We assume that each manufacturer f sets wholesale prices for its products at levels that maximizes the manufacturer's profit, i.e., manufacturer f solves the following optimization problem:

$$\max_{p_j^w \,\forall j \in \mathcal{F}_f} \Pi_f = \max_{p_j^w \forall j \in \mathcal{F}_f} \left[\sum_{j \in \mathcal{F}_f} (p_j^w - mc_j^w) M * s_j\big(p(p_j^w), \xi, \Theta\big) \; - C_f \right] \quad (1.13)$$

where $s_j\big(p(p_j^w), \xi, \Theta\big)$ is the market share of product *j*, which is a function of the retail prices of all products, and these retail prices are a function of wholesale prices; mc_j^w is the marginal cost the manufacturer incurs to produce product *j*; and C_f is the fixed cost of production. A Nash equilibrium wholesale price p_j^w of any product *j* produced by firm *f* must satisfy the first-order condition:

$$s_j\big(p(p_j^w), \xi, \Theta\big) + \sum_{k \in \mathcal{F}_f} (p_k^w - mc_k^w) \frac{\partial s_k\big(p(p_j^w), \xi, \Theta\big)}{\partial p_j^w} = 0 \quad (1.14)$$

First, let T^F be a $J \times J$ matrix of appropriately positioned zeros and ones that describes ownership structure of the J products across manufacturers, and let T_{kl}^F be an element in matrix T^F, where

$$T_{kl}^F = \begin{cases} 1, & if \; \exists \; f: \{k, l\} \subset \mathcal{F}_f \\ 0, & otherwise \end{cases}$$

that is, the element in row k and column l of matrix T^F is equal to one if there exists a manufacturer f that produces product k and product l, otherwise element T_{kl}^F is equal to zero. The way in which matrix T^F is used in subsequent analyses; this matrix effectively determines which sets of products manufacturers jointly price. Note that $T^F \neq T^R$ since manufacturers' ownership structure of the products is different from retailers' ownership structure of the products.

Second, let Δ^F be a $J \times J$ matrix of first-order derivatives of product market shares with respect to wholesale prices, where element $\Delta_{kl}^F = \frac{\partial s_k(p, \xi, \Theta)}{\partial p_l^w}$, and matrix Δ^F can be expressed as:

$$\Delta^F = \begin{pmatrix} \dfrac{\partial s_1}{\partial P_1^w} & \cdots & \dfrac{\partial s_J}{\partial P_1^w} \\ \vdots & \ddots & \vdots \\ \dfrac{\partial s_1}{\partial P_J^w} & \cdots & \dfrac{\partial s_J}{\partial P_J^w} \end{pmatrix}$$

The set of first-order conditions that follow from profit maximizing price-setting behavior of manufacturers can be written in matrix notation as follows:

$$s(p) + (T^F * \Delta^F) \times (p^w - mc^w) = 0 \tag{1.15}$$

where $(T^F * \Delta^F)$ is an element-by-element multiplication of the two matrices; $s(\cdot)$, p^w, and mc^w are $J \times 1$ vectors of predicted product shares, wholesale prices, and manufacturers' marginal costs, respectively. The first-order condition in equation (1.15) can be re-arranged to obtain manufacturers' product-level markups as follows:

$$p^w - mc^w = -(T^F * \Delta^F)^{-1} \times s(p) = markup^F(p, \xi; \Theta, T^F) \tag{1.16}$$

Note that product-level manufacturer markups are a function of demand-side variables and parameter estimates, as well as the product ownership structure matrix across manufacturers, T^F. As such, with demand parameter estimates in hand, $\widehat{\Theta}$, and a given structure for matrix T^F, the right-hand-side of equation (1.16) allows us to compute product-level manufacturer markups.

The total markup on each product can be obtained by summing retailers' product-level markups and manufacturers' product-level markups. As such, we can obtain the equation for total markup on each product by summing equation (1.12) and equation (1.16):

$$[p - p^w - mc^r] + [p^w - mc^w] = [-(T^R * \Delta^R)^{-1} \times s(p)] + [-(T^F * \Delta^F)^{-1} \times s(p)]$$

$$p - mc = markup^R(p, \xi; \Theta, T^R) + markup^F(p, \xi; \Theta, T^F) \tag{1.17}$$

where mc is the vector of the sum of marginal cost from both retailers and manufacturers, i.e.,

$$mc = mc^r + mc^w \tag{1.18}$$

To facilitate subsequent econometric estimation of the relevant supply-side equation, it is convenient to re-write equation (1.17) as follows:

$$p - markup^R(p, \xi; \Theta, T^R) - markup^F(p, \xi; \Theta, T^F) = mc \tag{1.19}$$

It is possible that competition in the milk industry is better characterize by strategically active price-setting milk manufacturers, but strategically passive price-setting milk retailers. In this situation milk retailers simply set prices to cover their effective marginal cost of operating, i.e., retailers have zero markups, $p - p^w - mc^r = 0 = markup^R(p, \xi; \Theta, T^R)$. Based on the supply-side derivations laid out above, the relevant supply-side equation under active price-setting manufacturers, but passive retailers is:

$$p - markup^F(p, \xi; \Theta, T^F) = mc \tag{1.20}$$

The analysis answers the following two key questions: (i) Whether Dean Food's acquisition of two milk-processing plants and associated brands of milk products owned by Foremost Farms resulted in the newly acquired brands of milk products being jointly priced with Dean Food's pre-existing brands of milk products?; and (ii) In accordance with the DOJ's final order of divestiture, whether Dean Food's divestiture of one milk-processing plant and associated brands of milk products resulted in the divested brands of milk products being priced separately from the brands of milk products owned by Dean Foods? As stated above, matrix T^F in the supply model effectively determines which sets of products manufacturers jointly price. As such, we define two versions of matrix T^F to capture contrasting price-setting behavior of Dean Foods: (i) $T^F_{factual}$ is used in supply models that assume Dean Foods chooses to jointly price the newly acquired brands of milk products with its pre-existing brands of milk products, and subsequent to the divestiture, the divested brands of milk products are priced separately from the brands of milk products owned by Dean Foods; and (ii) $T^F_{counterfactual}$ is used in supply models that assume Dean Foods chooses to separately price the newly acquired brands of milk products from its pre-existing brands of milk products, and subsequent to the divestiture, the divested brands of milk products are priced jointly with the brands of milk products owned by Dean Foods. These two versions of matrix T^Fresult in the following four distinct supply models:

Supply Model 1: Active Price-Setting by Manufacturers and Retailers with Price-setting behavior of Manufactures Captured by $T^F_{factual}$:

$$p - markup^R(p, \xi; \Theta, T^R) - markup^F\left(p, \xi; \Theta, T^F_{factual}\right) = mc_1$$

Supply Model 2: Active Price-Setting by Manufacturers and Retailers with Price-setting behavior of Manufactures Captured by $T^F_{counterfactual}$:

$$p - markup^R(p, \xi; \Theta, T^R) - markup^F\left(p, \xi; \Theta, T^F_{counterfactual}\right) = mc_2$$

Supply Model 3: Active Price-setting Manufacturers but Passive Retailers, with Price-setting behavior of Manufactures Captured by $T^F_{factual}$:

$$p - markup^F\left(p, \xi; \Theta, T^F_{factual}\right) = mc_3$$

Supply Model 4: Active Price-setting Manufacturers but Passive Retailers, with Price-setting behavior of Manufactures Captured by $T^F_{counterfactual}$:

$$p - markup^F\left(p, \xi; \Theta, T^F_{counterfactual}\right) = mc_4$$

To facilitate econometric estimation of the supply models laid out above, we parametrize the marginal cost function on the right-hand-side of each equation. As such, we now consider marginal cost-shifting variables to facilitate a parametric specification of a marginal cost function.

It is well-known that fluid milk is highly perishable and milk packaging is important to effectively guarantee the quality of milk and maintain the nutrition during storage and transportation. The type of packaging material used is one of the critical factors to influence the production cost of milk products. For example, compared to plastic and carton packaging, glass packaging is more costly to manufacture (Karaman, 2015). In our dataset, there are three types of packaging materials: glass; plastic; and paperboard carton. Therefore, we use package material zero-one dummy variables as one set of marginal cost shifters.

Fat content is an expensive component of milk and a key factor in determining how much dairy farmers are paid for milk (Vaclacik and Christian, 2007). Therefore, we also include a fat content dummy variable in the marginal cost specification. The zero-one fat content dummy variable takes a value of one for whole milk products, and zero otherwise.

Plant-based milk is a popular substitute for dairy milk. Two widely consumed plant-based milk substitutes are soy milk and almond milk (Yadav et.al, 2017). Obviously, the production process for plant-based milk differs from dairy milk, and therefore it is likely that there are differences in production costs across these types of milk. As such, we use as marginal cost-shifting variables, zero-one dummy variables that will capture differences in marginal costs across plant-based versus dairy milk products.

Organic milk virtually prohibits the use of antibiotics and hormones in the cow herd and the use of synthetic chemicals in the production of cattle feed. Farms with organic milk production are also required to accommodate the animals' natural nutritional and behavioral requirements. The tougher standards and additional requirements in organic milk production are likely to result in higher production costs compared with conventional milk. On average, organic dairies have estimated costs that are approximately \$5 to \$8 per hundredweight (cwt) higher than conventional dairies (McBride and Greene, 2009). As such, we also include a zero-one organic milk dummy in the marginal cost specification.

Electricity is viewed as the most important direct input in the dairy industry, which motivated us to use the interaction of electricity price with milk brand dummies as instruments for retail price of milk in the demand model. The same rationale motivates us to use these demand model instruments as marginal cost-shifting variables in the marginal cost specification.

Based on the above information, we assume the following specification for the marginal cost function:

$$mc = \lambda + \psi W + \kappa \tag{1.21}$$

where λ is a vector of the sum of time fixed effects, geographic market fixed effects, and product fixed effects;[8] W is the vector of cost shifters including the package material dummies, the fat content dummy, the milk type dummies (full lactose milk, reduced lactose milk, full lactose milk with acidophilus, soy milk, almond milk), the organic dummy, and electricity price interacted with brand dummies; ψ is a vector of parameters associated with marginal cost-shifting variables in W; and κ captures random shocks to marginal cost that are unobserved to us the researchers, but observed by firms. Under the assumption that $E(\kappa|\lambda, W) = 0$, λ and ψ can be estimated consistently.

1.4.4 Non-nested Statistical Test for Supply Model Selection

As revealed in the discussion above, there are four supply models to statistically compare. For notational simplicity, let any two of the supply models being statistically compared be denoted by h and h', where the two supply models are compactly represented by the following two equations:

$$p - Total\_Markup^{h} = \lambda^{h} + \psi^{h} W + \kappa^{h} \tag{1.22}$$

and

$$p - Total\_Markup^{h'} = \lambda^{h'} + \psi^{h'} W + \kappa^{h'} \tag{1.23}$$

where $Total\_Markup$ is a vector of the sum of retailer and manufacturer markups. In the passive retailer supply model, as the retailers' markup is zero, then the $Total\_Markup$ is the manufacturers' markup.

Assume that random shocks κ_j^h and $\kappa_j^{h'}$ are normally distributed. We define LL_j^h as the optimal value of the log likelihood function for model h evaluated at observation j, and $LL_j^{h'}$ is defined analogously for model h'. Furthermore, let $\phi(\cdot)$ represents the normal probability

[8] We define a product by the unique combination of non-price characteristics and retail store. As such, our product fixed effects control for a composite of product features that are correlated with marginal cost of a product.

density function, and *LR* represents the likelihood ratio statistic for comparing model h and h'. The definitions above result in the following equations:

$$LL_n^h = \log[\phi(p_n - total\_markup_n^h - \lambda^h - \psi^h W_n)] \tag{1.24}$$

$$LL_n^{h'} = \log\left[\phi\left(p_n - total\_markup_n^{h'} - \lambda^{h'} - \psi^{h'} W_n\right)\right] \tag{1.25}$$

$$LR = \sum_{n=1}^{N}(LL_n^h - LL_n^{h'}) \tag{1.26}$$

Vuong (1989) shows that the likelihood ratio statistic, LR, can be normalized by its own variance, where its variance is given by:

$$v^2 = \frac{1}{N}\sum_{n=1}^{N}(LL_n^h - LL_n^{h'})^2 - \left[\frac{1}{N}\sum_{n=1}^{N}\left(LL_n^h - LL_n^{h'}\right)\right]^2 \tag{1.27}$$

Therefore, the non-nested test statistic, $Q = N^{0.5}\frac{LR}{v}$, is asymptotically standard normal distributed under the null hypothesis that model h and model h' being compared by the test are asymptotically equivalent. Based on a one-tale test at 5% level of statistical significance, the selection procedure involves comparing Q with the critical values, 1.64 and -1.64. $Q > 1.64$ implies that model h' is statistically rejected in favor of model h. $Q < -1.64$ implies that model h is statistically rejected in favor of model h'. $-1.64 < Q < 1.64$ indicates that model h and model h' cannot be statistically distinguished.

1.5 Econometric Estimation and Inferences

1.5.1 Demand Estimation

Parameter estimates for the random coefficients logit model of demand are reported in Table 1.3. We also estimate the standard logit version of the demand model using Ordinary Least Square (OLS) and Two Stage Least Square (2SLS) estimators. Estimation results for the standard logit version of the demand model are reported in Table A.1 and Table A.2 located in the Appendix. The reader can also find in Table A.2 a Wu-Hausman statistical test to examine the endogeneity of the price. The results of this test provide strong evidence that price is indeed endogenous, thus confirming the need for price instruments. Panel A of Table 1.3 reports the estimated coefficients in the mean utility function, which are associated with the linear parameters in equation (1.4), while Panel B presents parameter estimates that measure consumers' taste heterogeneity, which are the non-linear parameters in equation (1.5).

We estimated the demand model separately for four different package sizes, which is important for allowing consumer preferences and therefore demand parameters to differ across package sizes. Consumer preferences may differ across package sizes if firms are able to effectively price discriminate and segment consumers based on their differing preferences across package sizes. As shown in summary statistics of the data reported above in Table1.2, mean prices per gallon of milk products within each of the four package sizes differ across the package sizes. In particular, the summary data evidence on prices suggests that mean price per gallon of milk is lower among milk products in larger package sizes. Such quantity discounting is suggestive of price discriminatory practices designed to segment different consumer groups by package sizes [see chapter 6 in Pepall, Richards and Norman (2014)]. Effective segmentation of consumer types by package sizes implies that we may observe consumers having contrasting preferences for a given product attribute in different package sizes of milk products.

Across the four different package sizes of milk, the price coefficients are negative and statistically significant, suggesting that, on average, consumers' level of utility is inversely related to the price of the product. As such, consistent with expectation, if non-price product characteristics across competing products are equal, then our estimated price effect implies that consumers will choose the milk product that has the lower price.

The estimated coefficients on the fat-content dummy variable are positive and statistically significant in the package size of 16 ounces and 0.5 gallon, however, they are negative and statistically significant in both 32 ounces and 1 gallon package size. Recall that the fat-content dummy variable takes a value of one for whole milk products, and zero otherwise. As such, controlling for other product characteristics, the results indicate that consuming whole milk in 16 ounces and 0.5 gallon sizes would increase the average consumer's utility, but in 32 ounces and 1 gallon package size consumers prefer non-whole milk. These results suggest that consumers who typically purchase milk products in package sizes of 16 ounces and 0.5 gallon containers have a different preference for whole milk than consumers who typically purchase milk products in package sizes of 32 ounces and 1 gallon.

The coefficient estimates on the vanilla flavor dummy variable are negative and statistically significant in both 16 ounces and 0.5 gallon package sizes, suggesting that compared with vanilla flavor, consumers prefer regular white milk. The vanilla flavoring added to milk can either be artificial or real, and vanilla extract often contains alcohol. As such, perhaps driven by a greater concern for health, the typical consumers of 16 ounces and 0.5 gallon package sizes of milk products prefer to avoid milk products with added vanilla flavoring. However, in the package sizes of 32 ounces and 1 gallon, the coefficient estimates on the vanilla flavor dummy variable are positive and statistically significant, indicating that in these two package sizes of milk, relative to regular white milk, the vanilla flavor of milk generate higher utility for the average consumer.

There is a greater variety of flavored milk in the 0.5 gallon package size than any of the other three sizes. The coefficient estimates on the "original" and "plain" flavor dummies are negative and statistically significant. These results suggest that within the 0.5 gallon package size, regular white milk products generate higher utility for the average consumer than flavored milk products. Among the three flavors of milk, vanilla is most preferred, followed by plain and original respectively. The ordering of preference over flavors of milk may in part be driven by the fact that the original flavor is sweetest and carries more calories compared to the flavors of vanilla and plain.

There are three types of milk in the package size of 32 ounces, which are: full lactose milk; reduced lactose milk; and soymilk. However, the number of observations for reduced lactose and soymilk products in the 32 ounces package size are sufficiently small such that our estimation cannot separately identify marginal utility parameters associated with these two types of milk products. As such, among the three types of milk products in the 32 ounces package size, we only include the full lactose dummy variable in the demand estimation. The coefficient estimate on the full lactose dummy variable is positive and statistically significant, revealing that the regular full lactose milk yields positive marginal utility relative to reduced lactose and soymilk for the average consumer.

In the package size of 0.5 gallon there are five types of milk, including three types of dairy milk and two types of plant-based milk. The excluded milk type dummy variable from this regression model is Full Lactose. As such, each of the four coefficient estimates on the milk type dummy variables included in the regression model compares consumers' preference for the milk type in question relative to full lactose milk type. The four coefficient estimates on milk type dummy variables are negative and statistically significant, suggesting that relative to each of the other four milk types, full lactose milk yields higher utility for the average consumer. In other words, full lactose milk is the most preferred milk type among the five milk types considered. Among the other four milk types, reduced lactose is most preferred, followed by soy milk, almond milk, and milk with acidophilus respectively.

The coefficient estimate on the "organic" dummy variable in the package size of 0.5 gallon is negative and statistically significant, suggesting that although organic milk is free of hormones and antibiotics, consumers of milk products in 0.5 gallon packaging containers prefer purchasing non-organic to organic milk.. In contrast, consumers of milk products in 1 gallon packaging containers prefer purchasing organic to non-organic milk, as evidenced by the positive and statistically significant coefficient estimate on the "organic" dummy variable.

From Panel B of Table 1.3, the variation in consumers' sensitivity to price changes, as measured by the coefficient estimates on $v \times Real\ Milk\ Price$, are statistically significant in three package sizes except for 0.5 gallon, indicating that consumers are heterogeneous with respect to their responsiveness to price changes for the package sizes of 16 ounces, 32 ounces, and 1 gallon. In the package sizes of 16 ounces and 0.5 gallon, the positive and statistically significant coefficient estimates on the interaction variable of income with price, i.e. the coefficient estimates on $Income \times Real\ Milk\ Price$, suggest that consumers with higher incomes are less sensitive to price changes. In the package sizes of 32 ounces and 1 gallon, there is no evidence that consumers' income level significantly influences their sensitivity to changes in milk price. Among all four package sizes of milk, consumers' age does not seem to influence heterogeneity in taste for the fat content attribute of milk products.

Table 1.3: Demand Estimation for Four Package Sizes of Milk

	Random Coefficients Logit Model							
	Panel A: Variables and Parameters in the mean utility function [parameters in $\theta_1 = (\beta, \alpha, \rho_{year}, \tau_{month}, \gamma_{market})$].							
	Size 1 (16 ounces container)		Size 2 (32 ounces container)		Size 3 (0.5 gallon container)		Size 4 (1 gallon container)	
	Coefficient Estimates	Std. Error	Coefficient Estimates	Std. Error	Coefficient Estimates	Std. Error	Coefficient Estimates	Std. Error
Real Milk Price	-199.10**	9.56	-138.18**	22.97	-87.94**	16.94	-345.85**	83.54
Fat Content (=1 if whole milk) [a]	1.76**	0.15	-1.18**	0.06	0.35**	0.03	-0.38**	0.10
Flavor: Vanilla [a]	-1.99**	0.04	0.08**	0.02	-1.19**	0.01	0.16**	0.04
Flavor: Original [a]	-	-	-	-	-1.38**	0.01	-	-
Flavor: Plain [a]	-	-	-	-	-1.29**	0.01	-	-
Milk type: Full lactose [a]	-	-	2.16**	0.06	-	-	-	-
Milk type [1]: Reduced lactose [a]	-	-	-	-	-0.87**	0.01	-	-
Milk type[2]: Milk with acidophilus [a]	-	-	-	-	-3.40**	0.02	-	-
Milk type: Soy milk [a]	-	-	-	-	-1.49**	0.01	-	-
Milk type: Almond milk [a]	-	-	-	-	-2.12**	0.02	-	-
Organic (=1 if organic) [a]	-	-	-	-	-0.03**	0.01	0.35**	0.04
Constant [a]	-0.32	0.48	1.35**	0.70	2.91**	0.28	-10.78**	0.09
Time fixed effects	YES		YES		YES		YES	
Product fixed effects	YES		YES		YES		YES	
Market fixed effects	YES		YES		YES		YES	
	Panel B: Variables and Parameters that measure taste heterogeneity across Consumers [parameters in $\theta_2 = (\Gamma, \Sigma)$].							
$v \times Constant$	-0.41	0.64	0.29	0.83	0.35	0.87	0.42	0.74
$v \times Real\ Milk\ Price$	-20.97**	4.86	29.29**	4.94	4.31	18.48	71.44**	28.86
$v \times Fat\ Content$	0.38	2.58	0.83	1.25	0.48	4.63	0.41	1.69
$Income \times Real\ Milk\ Price$	10.11**	2.16	1.65	13.22	9.00**	0.97	-5.83	143.83
$Age \times Fat\ Content$	3.48	21.85	-5.71	5.10	3.02	25.04	-14.77	21.70
GMM Objective Function Value	0.0088		0.0130		0.0152		0.0310	
Observations	21,114		29,901		158,439		45,267	

Notes: *indicates statistical significance at the 10% level, **indicates statistical significance at the 5% level
[1] Reduced lactose also includes lactose free milk.
[2] The milk is full lactose with acidophilus
[a] Coefficient estimates from the Generalized Least Square regression of estimated product fixed effects on non-price product characteristics.

1.5.2 Elasticities

Given the structural demand estimates, price elasticities of demand for each differentiated product can be calculated. Since a particular market is defined as the combination of time and geographic location, there are 420 unique markets in the dataset of each package size. So as to get a sense of own- and cross-price elasticities of products owned by Dean Foods and Foremost Farms, we select the markets located in Green Bay and Milwaukee in March 2007, which is a time period prior to Dean Food's acquisition of Foremost Farm's two processing plants.

In Table 1.4 we report mean own- and cross-price elasticities by select firms in our data.[9] The firm-level means are obtained by averaging across the product-level elasticities based on the set of products owned by the relevant firms. The table shows mean own-price elasticity estimates ranging from -2.746 to -13.967. The literature frequently shows lower own-price elasticities for milk, however, the reported estimates in these studies are typically generated at a level more aggregated than the defined milk products used in our study. For example, Gould (1995) reported own-price elasticities of approximately -0.60 for reduced fat milk in the United States. In a study by Schmit et al. (2002), the total milk own-price elasticity is -0.243. Davis et al. (2009) pointed out that non-price product attributes play an important role in the empirical estimation of demand elasticities. In particular, when more non-price attributes are included in defining products and in demand estimation, then demand elasticity estimates found in the literature are in line with our estimates for all package sizes but the 16 ounces package size, a package size that none of the studies in the relevant literature considered. For example, Lopez and Lopez (2009) reported own-price elasticities ranging from -1.9 to -2.4 for different brands of milk. Kinoshita et al. (2001) found elasticities ranging from

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[9] We also calculate the own- and cross-elasticities of Kemps since DOJ's complaint mentioned that Kemps is a major competitor for Dean Foods and Foremost Farms in the five relevant markets.

-0.2 to -6.1 depending on the brand and location of purchase. Bonnet et al. (2015) found that own-price elasticities of demand for fluid milk vary between -1.79 and -6.56 based on an analysis of 25 brands and 7 retail stores.

The mean of own-price elasticity estimates reported in Table 1.4 differ across the four package sizes. In particular, the evidence suggests that the typical consumers of milk products in 16 ounces packaging are most sensitive to price changes, i.e., milk products in this package size have the largest own-price elasticity estimates, ranging from -10.77 to -13.97. Among the other three package sizes, consumers of milk products in 1 gallon packaging are most sensitive to price changes, own-price elasticities ranging from -6.39 to -7.85, followed by the price sensitivities of consumers of milk products in 32 ounces (own-price elasticities ranging from -4.749 to -5.96) and 0.5 gallon (own-price elasticities ranging from -2.75 to -3.40) packaging respectively. In Table 1.4, we only report the own- and cross-price elasticities for regular full lactose dairy milk. However, soy milk (brands: 8th Continent and Silk Light), organic milk (brands: Organic Valley, Horizon Organic and Wisconsin Organics), and reduced lactose dairy (brands: Deans Easy, Hood Lactaid, Land O' Lakes Dairy Ease) all have larger own-price elasticities than regular full lactose dairy milk.[10] All the cross-price elasticities are positive and statistically significant, but much smaller in absolute magnitudes than own-price elasticities.

Among milk products contained in the package size of 16 ounces in the Green Bay market, the mean own-price elasticity of products owed by Dean Foods is smaller compared with mean own-price elasticity of products owed by Foremost Farms and Kemps respectively. However, among milk products contained in the package size of 16 ounces in the Milwaukee market, the dairy milk offered by Kemps have the lowest mean own-price elasticities compared with mean own-price elasticity of products owed by Foremost Farms and Dean Foods respectively. Referring to the cross-price elasticities, the dairy milk products offered by Dean

[10] The own-price elasticities of brands owned by these 3 firms in the two selected markets are reported in the Appendix.

Foods are more substitutable with Foremost Farm's dairy milk products rather than with Kemp's dairy milk products. In the package size of 32 ounces, Dean Foods has the highest own-price elasticity in both selected markets, followed by Foremost Farms and Kemps. As in the package size of 16 ounces, dairy milk products with 32 ounces packaging offered by Dean Foods are still more substitutable with dairy milk products in this package size offered by Foremost Farms.

Although in the package size of 0.5 gallon, consumers of Dean Food's dairy milk products are the most sensitive to price change in the Green Bay market (highest mean own-price elasticity), these products have the lowest own-price elasticity in the Milwaukee market. In both markets, the mean cross-price elasticity between dairy milk products of Dean Foods and Foremost Farms is still higher than the mean cross-price elasticity between dairy milk products of Dean Foods and Kemps. Last, in the container size of 1 gallon, dairy milk products of Dean Foods have the lowest mean own-price elasticity in both markets.

Table 1.4: Mean Estimated Own- and Cross-Price Elasticities

Market: Green Bay in March 2007				Market: Milwaukee in March 2007			
	Dean Foods	Foremost Farms	Kemps		Dean Foods	Foremost Farms	Kemps
Size 1: (16 ounces)				**Size 1 (16 ounces)**			
Dean Foods	-11.6194**	0.00028**	0.00016**	Dean Foods	-10.9011**	0.00103**	0.00080**
	(0.1538)	(5.51^{E}-05)	(3.00^{E}-05)		(0.2031)	(0.0001)	(7.82^{E}-05)
Foremost Farms	0.00021**	-12.7289**	0.00017**	Foremost Farms	0.00091**	-11.3917**	0.00102**
	(4.83^{E}-05)	(0.5670)	(3.00^{E}-05)		(0.0001)	(0.2751)	(0.0001)
Kemps	0.00033**	0.00023**	-13.9675**	Kemps	0.00099**	0.00069**	-10.7734**
	(9.37^{E}-05)	(8.62^{E}-05)	(1.2329)		(8.15^{E}-05)	(5.57^{E}-05)	(0.2569)
Size 2: (32 ounces)				**Size 2: (32 ounces)**			
Dean Foods	-5.8992**	0.00033**	0.00025**	Dean Foods	-5.9606**	0.00054**	0.00024**
	(0.1505)	(1.7^{E}-05)	(1.00^{E}-05)		(0.1625)	(4.55^{E}-05)	(1.29^{E}-05)
Foremost Farms	0.00017**	-5.1577**	0.00022**	Foremost Farms	0.00013**	-5.4278**	0.00014**
	(1.30^{E}-05)	(0.1707)	(1.30^{E}-05)		(1.16^{E}-05)	(0.0576)	(1.24^{E}-05)
Kemps	0.00016**	0.00028**	-4.7496**	Kemps	0.00022**	0.00044**	-4.8710**
	(2.30^{E}-05)	(2.50^{E}-05)	(0.1111)		(1.25^{E}-05)	(3.80^{E}-05)	(0.0270)
Size 3: (0.5 gallon)				**Size 3: (0.5 gallon)**			
Dean Foods	-2.8921**	0.00072**	0.00060**	Dean Foods	-2.8055**	0.00040**	0.00020**
	(0.0002)	(0.0001)	(0.0001)		(0.0747)	(3.00^{E}-05)	(2.00^{E}-05)
Foremost Farms	0.00022**	-2.7460**	0.00059**	Foremost Farms	0.00025**	-3.2638**	0.00020**
	(2.52^{E}-05)	(0.0791)	(8.82^{E}-05)		(3.00^{E}-05)	(0.1975)	(2.00^{E}-05)
Kemps	0.00023**	0.00072**	-2.8616**	Kemps	0.00026**	0.00042**	-3.3990**
	(2.93^{E}-05)	(9.36^{E}-05)	(0.1742)		(2.00^{E}-05)	(2.00^{E}-05)	(0.1111)
Size 4: (1 gallon)				**Size 4: (1 gallon)**			
Dean Foods	-6.3935**	0.02421**	0.03820**	Dean Foods	-6.7046**	0.01265**	0.01307**
	(0.1298)	(0.0028)	(0.0071)		(0.1643)	(0.0009)	(0.0010)
Foremost Farms	0.00728**	-6.5634**	0.03968**	Foremost Farms	0.01872**	-7.8493**	0.01812**
	(0.0005)	(0.1823)	(0.0053)		(0.0018)	(0.0660)	(0.0011)
Kemps	0.00746**	0.02560**	-6.5869**	Kemps	0.01716**	0.01614**	-7.2944**
	(0.0008)	(0.0032)	(0.4200)		(0.0014)	(0.0008)	(0.1798)

Noted: **indicates statistical significance at the 5% level, standard error is reported in parenthesis.

1.5.3 Non-nested Test on Different Supply Models

After estimating the demand model, we compute product-level markups and recover product-level marginal costs for each of the four supply models. The non-nested likelihood ratio statistical test developed by Vuong (1989) is then performed to assess which model better approximates price-setting behavior during merger periods and divestiture periods respectively. As stated previously, we refer to merger periods as the time periods in our data over which Dean Foods owned the two dairy processing plants acquired from Foremost Farms, while divestiture periods are the time periods subsequent to Dean Foods' divestiture of the Waukesha plant.

According to the IRI dataset, beginning in January 2008 the ownership of milk product brands such as "Golden Guernsey" and "Morning Glory" changed from Foremost Farms to Dean Foods. As such, January 2008 is used as the effective beginning of the merger period associated with Dean Food's acquisition of the two milk processing plants from Foremost Farms. On January 22, 2010, the Department of Justice (referred to DOJ) filed a complaint against Dean Foods, with the purpose to disassemble the acquisition. According to the DOJ's final judgment of this case, Dean Foods divested one milk plant to Open Gate Capital in January 2012. As we subsequently make clear in the discussion, while the relevant merger periods differ across package sizes and relevant milk brands, all merger periods used in the analysis fall within the timeframe January 2008 to December 2011. Periods subsequent to January 2012 are used for the divestiture periods.

1.5.3.1 Non-nested Test on Different Supply Models: Merger Period

For milk products in 16 ounces package containers, there is only one milk brand "Golden Guernsey Morning Glory" involved in this merger. Based on the available dataset, this milk brand was owned by Dean Foods from January 2008 to September 2009, therefore, we define the merger period from January 2008 to September 2009.

Table 1.5 presents the non-nested test statistics for pairwise comparisons of the four supply models for milk products in 16 ounces package containers during the merger period. For Table 1.5 and subsequent tables that report non-nested test statistics, a positive statistic value in the table that is greater than 1.64 suggests that the model in the row is statistically preferred to the comparison model in the column, while a negative statistic value in the table that is less than -1.64 suggests that the model in the column is statistically preferred to the comparison model in the row. If the statistic value in the table lies between -1.64 and 1.64, then the two models being compared are statistically indistinguishable. Among the two supply models with active price-setting by manufacturers and retailers (Model 1 and Model 2), the supply model that assumes Dean Foods chooses to jointly price the newly acquired brands of milk products with its pre-existing brands of milk products (Model 1) is statistically preferred. Similarly, among the two supply models with active price-setting by manufacturers but passive retailers (Model 3 and Model 4), we again find that the supply model that assumes Dean Foods chooses to jointly price the newly acquired brands of milk products with its pre-existing brands of milk products (Model 3) is statistically preferred. As such, among milk products in 16 ounces package containers, the evidence is clear that Dean Foods chooses to jointly price the newly acquired brands of milk products with its pre-existing brands of milk products. Such cooperative price-setting behavior across Dean Foods's pre-existing brands and brands previously owned by Foremost Farms validates the anticompetitive concern expressed by DOJ. However, the non-nested test statistics cannot distinguish whether the supply model with active price-setting retailers is preferred to the supply model with passive retailers.

Table 1.5: Results of Non-Nested Test of 16 Ounces Package Size during the Merger Period

Merger period (Jan, 2008 – Sep, 2009)	Model 2: Active Price-setting Manufacturers and Retailers (Non-cooperative pricing)	Model 3: Active Price-setting Manufacturers, but Passive Retailers (Cooperative pricing)	Model 4: Active Price-setting Manufacturers, but Passive Retailers (Non-cooperative pricing)
Model 1: Active Price-setting Manufacturers and Retailers (Cooperative pricing)	2.906**	0.779	0.782
Model 2: Active Price-setting Manufacturers and Retailers (Non-cooperative pricing)	-	0.776	0.779
Model 3: Active Price-setting Manufacturers, but Passive Retailers (Cooperative pricing)	-	-	2.931**

Notes: 1. A positive statistic value in the table that is greater than 1.64 suggests that the model in the row is statistically preferred to the comparison model in the column, while a negative statistic value in the table that is less than -1.64 suggests that the model in the column is statistically preferred to the comparison model in the row. If the statistic value in the table lies between -1.64 and 1.64, then the two models being compared are statistically indistinguishable. 2. **indicates that the two compared models can be statistically distinguished at the 5% level.

In the package size of 32 ounces, there are three brands involved in the acquisition, "Golden Guernsey", "Golden Guernsey Morning Glory" and "Morning Glory". The ownership of all these three brands changed from Foremost Farms to Dean Foods in January 2008. However, the time periods over which Dean Foods owned these brands differ. The brands "Golden Guernsey" and "Golden Guernsey Morning Glory" were owned by Dean Foods from January 2008 to April 2010 and from January 2008 to December 2011, respectively, while the brand "Morning Glory" was owned by Dean Foods from January 2008 to December 2012. As such, for the package size of 32 ounces, we use as the merger period January 2008 to December 2011. Table 1.6 presents the non-nested test statistics for pairwise comparisons of the four supply models for milk products in 32 ounces package containers during the merger period. The statistic values in Table 1.6 suggest that the supply model with active price-setting by manufacturers and retailers, and assumes Dean Foods chooses to separately price the newly acquired brands of milk products from its pre-existing brands of milk products (Model 2) is statistically preferred when compared with each of the other three supply models. In other words, for milk products in 32 ounces package containers, Model 2 best approximates price-setting behavior of firms during the merger period. This result is inferred from fact that the non-nested test statistic value in the first column of the table (-3.975) is negative and less than -1.64, while the non-nested test statistic values in the second row (4.44 and 4.43) are positive and greater than 1.64. Such non-cooperative price-setting behavior across Dean Foods's pre-existing and newly acquired brands does not support the concern expressed by DOJ.

Table 1.6: Results of Non-Nested Test of 32 Ounces Package Size during the Merger Period

Merger period (Jan, 2008 – Dec, 2011)	Model 2: Active Price-setting Manufacturers and Retailers (Non-cooperative pricing)	Model 3: Active Price-setting Manufacturers, but Passive Retailers (Cooperative pricing)	Model 4: Active Price-setting Manufacturers, but Passive Retailers (Non-cooperative pricing)
Model 1: Active Price-setting Manufacturers and Retailers (Cooperative pricing)	-3.975**	4.438**	4.428**
Model 2: Active Price-setting Manufacturers and Retailers (Non-cooperative pricing)	-	4.441**	4.432**
Model 3: Active Price-setting Manufacturers, but Passive Retailers (Cooperative pricing)	-	-	-7.484**

Notes: 1. A positive statistic value in the table that is greater than 1.64 suggests that the model in the row is statistically preferred to the comparison model in the column, while a negative statistic value in the table that is less than -1.64 suggests that the model in the column is statistically preferred to the comparison model in the row. If the statistic value in the table lies between -1.64 and 1.64, then the two models being compared are statistically indistinguishable. 2. **indicates that the two compared models can be statistically distinguished at the 5% level.

In the package size of 0.5 gallon, there are two brands involved in the acquisition, "Golden Guernsey" and "Morning Glory". The "Golden Guernsey" brand is produced by Waukesha plant, and therefore its ownership changed from Foremost Farms to Dean Foods in January 2008. However, according to DOJ's final judgment, Dean Foods divested Waukesha plant to Open Gates Capital Cooperation in January 2012, as such, the ownership of this brand changed again from Dean Foods to Open Gate in January 2012. The brand “Morning Glory” belongs to another milk plant located in De Pere, and Dean Foods maintained ownership of this plant even after DOJ’s divestiture order. Therefore, Dean Foods owned the brand “Morning Glory” from January 2008 through the end of our data set in December 2012. As such, in case of the 0.5 gallon package size, in order to analyze the pricing behavior of Dean Foods during a period in which it owned both of the newly acquired brands, we use for the merger period January 2008 to December 2011.

Table 1.7 presents the non-nested test statistics for pairwise comparisons of the four supply models for milk products in 0.5 gallon package containers during the merger period. The statistic values in Table 1.7 suggest that the supply model with active price-setting by manufacturers, but passive retailers, and assumes Dean Foods chooses to jointly price the newly acquired brands of milk products with its pre-existing brands of milk products (Model 3) is statistically preferred when compared with each of the other three supply models. In other words, for milk products in 0.5 gallon package containers, Model 3 best approximates price-setting behavior of firms during the merger period. This result is inferred from fact that the non-nested test statistic values in the second column of the table (-33.531 and -33.531) are negative and less than -1.64, while the non-nested test statistic value in the third row (5.08) is positive and greater than 1.64. Such cooperative price-setting behavior supports the DOJ’s anticompetitive concern expressed in its complaint against Dean Foods.

Table 1.7: Results of Non-Nested Test of 0.5 Gallon Package Size during the Merger Period

Merger period (Jan 2008 – Dec 2011)	Model 2: Active Price-setting Manufacturers and Retailers (Non-cooperative pricing)	Model 3: Active Price-setting Manufacturers, but Passive Retailers (Cooperative pricing)	Model 4: Active Price-setting Manufacturers, but Passive Retailers (Non-cooperative pricing)
Model 1: Active Price-setting Manufacturers and Retailers (Cooperative pricing)	-3.067**	-33.531**	-33.531**
Model 2: Active Price-setting Manufacturers and Retailers (Non-cooperative pricing)	-	-33.531**	-33.531**
Model 3: Active Price-setting Manufacturers, but Passive Retailers (Cooperative pricing)	-	-	5.081**

Notes: 1. A positive statistic value in the table that is greater than 1.64 suggests that the model in the row is statistically preferred to the comparison model in the column, while a negative statistic value in the table that is less than -1.64 suggests that the model in the column is statistically preferred to the comparison model in the row. If the statistic value in the table lies between -1.64 and 1.64, then the two models being compared are statistically indistinguishable. 2. **indicates that the two compared models can be statistically distinguished at the 5% level.

Similar to the package size of 0.5 gallon, in the package size of 1 gallon, "Golden Guernsey" and "Morning Glory" are the two milk product brands involved in the acquisition. Furthermore, the merger period for milk products in 1 gallon package containers is the same as the merger period for milk products in 0.5 gallon package containers, January 2008 to December 2011. Table 1.8 presents the non-nested test statistics for pairwise comparisons of the four supply models for milk products in 1 gallon package containers during the merger period. It is evident from Table 1.8 that the non-nested test statistic values in the last column are negative and less than -1.64, suggesting that for milk products in 1 gallon package containers, Model 4 best approximates price-setting behavior of firms during the merger period. In particular, the supply model of active price-setting manufacturers, but passive retailers, which assumes Dean Foods chooses to separately price the newly acquired brands of milk products from its pre-existing brands of milk products (Model 4) is statistically preferred when compared with each of the other three supply models. Such non-cooperative price-setting behavior by Dean Foods does not support the DOJ's anti-competitive complaint.

In summary, during the relevant merger periods we find evidence of anticompetitive price-setting behavior in support of the DOJ's complaint against Dean Foods for milk products in 16 ounces and 0.5 gallon package containers, respectively. However, for milk products in 32 ounces and 1 gallon package containers, the evidence is not supportive of Dean Food's price-setting behavior being anticompetitive.

Table 1.8: Results of Non-Nested Test of 1 Gallon Package Size during the Merger Period

Merger period (Jan 2008 – Dec 2011)	Model 2: Active Price-setting Manufacturers and Retailers (Non-cooperative pricing)	Model 3: Active Price-setting Manufacturers, but Passive Retailers (Cooperative pricing)	Model 4: Active Price-setting Manufacturers, but Passive Retailers (Non-cooperative pricing)
Model 1: Active Price-setting Manufacturers and Retailers (Cooperative pricing)	-4.944**	-6.472**	-6.537**
Model 2: Active Price-setting Manufacturers and Retailers (Non-cooperative pricing)	-	-6.349**	-6.423**
Model 3: Active Price-setting Manufacturers, but Passive Retailers (Cooperative pricing)	-	-	-4.022**

Notes: 1. A positive statistic value in the table that is greater than 1.64 suggests that the model in the row is statistically preferred to the comparison model in the column, while a negative statistic value in the table that is less than -1.64 suggests that the model in the column is statistically preferred to the comparison model in the row. If the statistic value in the table lies between -1.64 and 1.64, then the two models being compared are statistically indistinguishable. 2. **indicates that the two compared models can be statistically distinguished at the 5% level.

1.5.3.2 Non-nested Test on Different Supply Models: Divestiture Period

As previously stated, the final judgment of DOJ requested Dean Foods to divest the Waukesha plant. To comply with the DOJ's order, Dean Food's sold the Waukesha plant to Open Gates Capital Cooperation. As such, beginning in January 2012, milk products with the brand name "Golden Guernsey", produced by the Waukesha plant, were owned by Open Gates Capital Cooperation instead of Dean Foods. In the IRI dataset, milk products with the brand name "Golden Guernsey" only exist in the package sizes of 0.5 gallon and 1 gallon. Therefore, we only perform non-nested statistical comparison tests across the different supply models for these two package sizes during the divestiture period, January 2012 to December 2012.

Table 1.9 presents non-nested test statistics for pairwise comparisons of the four supply models for milk products in 0.5 gallon package containers during the divestiture period. The non-nested test statistics in the first and second row suggest that for milk products in 0.5 gallon package containers, Model 1 and Model 2 better approximate price-setting behavior of firms during the divestiture period when each is compared to Model 3 and Model 4. A common feature of Model 1 and Model 2 is that they each assume active price-setting manufacturers and retailers. However, the difference between them is that Model 1 assumes milk products that belong to the divested brand, "Golden Guernsey", are priced separately from the brands of milk products owned by Dean Foods, while Model 2 assumes milk products that belong to the divested brand are cooperatively priced with the brands of milk products owned by Dean Foods. The non-nested statistic value that compares Model 1 and Model 2 is 1.127, which is positive but less than 1.64, suggesting that these two models cannot be statistically distinguished. In other words, market equilibrium outcomes that correspond to milk products with the "Golden Guernsey" brand being priced separately from milk products owned by Dean Foods are not statistically different from market equilibrium outcomes that correspond to "Golden Guernsey" milk products being priced cooperatively with milk products owned by Dean Foods. As such, for milk products in 0.5 gallon package containers, there is no evidence that DOJ's divestiture policy decision had a statistically significant impact on the market.

Table 1.9: Results of Non-Nested Test of 0.5 Gallon Package Size during the Divestiture Period

Merger period (Jan 2012 – Dec 2012)	Model 2: Active Price-setting Manufacturers and Retailers (Cooperative pricing)	Model 3: Active Price-setting Manufacturers, but Passive Retailers (Non-cooperative pricing)	Model 4: Active Price-setting Manufacturers, but Passive Retailers (Cooperative pricing)
Model 1: Active Price-setting Manufacturers and Retailers (Non-cooperative pricing)	1.127	35.212**	35.200**
Model 2: Active Price-setting Manufacturers and Retailers (Cooperative pricing)	-	35.225**	35.213**
Model 3: Active Price-setting Manufacturers, but Passive Retailers (Non-cooperative pricing)	-	-	1.192

Notes: 1. A positive statistic value in the table that is greater than 1.64 suggests that the model in the row is statistically preferred to the comparison model in the column, while a negative statistic value in the table that is less than -1.64 suggests that the model in the column is statistically preferred to the comparison model in the row. If the statistic value in the table lies between -1.64 and 1.64, then the two models being compared are statistically indistinguishable. 2. **indicates that the two compared models can be statistically distinguished at the 5% level.

Table 1.10 presents non-nested test statistics for pairwise comparisons of the four supply models for milk products in 1 gallon package containers during the divestiture period. The non-nested test statistics in the second column are negative (-14.461 and -14.603) and less than -1.64, suggesting that Model 3 better approximates price-setting behavior when compared to Model 1 and Model 2. Furthermore, non-nested test statistic in the third row is positive (4.229) and greater than 1.64, suggesting that Model 3 better approximates price-setting behavior when compared to Model 4. Therefore, for milk products in 1 gallon package containers, Model 3 best approximates price-setting behavior of firms during the divestiture period. In particular, the supply model of active price-setting manufacturers, but passive retailers, which assumes the milk products that belong to the divested brand, “Golden Guernsey”, are priced separately from the brands of milk products owned by Dean Foods (Model 3) is statistically preferred when compared with each of the other three supply models.

As such, for milk products in 1 gallon package containers, this non-cooperative price-setting behavior across the divested brand of milk products and brands of milk products owned by Dean Foods is consistent with the objective of the DOJ's divestiture policy decision.

In summary, for milk products in 0.5 gallon package containers, there is no evidence that DOJ's divestiture policy decision had a statistically significant impact on the market. However, for milk products in 1 gallon package containers during the divestiture period, the evidence of non-cooperative price-setting behavior across the divested brand of milk products and brands of milk products owned by Dean Foods is consistent with the objective of the DOJ's divestiture policy decision.

Table 1.10: Results of Non-Nested Test of 1 Gallon Package Size during the Divestiture Period

Merger period (Jan 2012 – Dec 2012)	Model 2: Active Price-setting Manufacturers and Retailers (Cooperative pricing)	Model 3: Active Price-setting Manufacturers, but Passive Retailers (Non-cooperative pricing)	Model 4: Active Price-setting Manufacturers, but Passive Retailers (Cooperative pricing)
Model 1: Active Price-setting Manufacturers and Retailers (Non-cooperative pricing)	7.060**	-14.461**	-14.479**
Model 2: Active Price-setting Manufacturers and Retailers (Cooperative pricing)	-	-14.603**	-14.573**
Model 3: Active Price-setting Manufacturers, but Passive Retailers (Non-cooperative pricing)	-	-	4.229**

Notes: 1. A positive statistic value in the table that is greater than 1.64 suggests that the model in the row is statistically preferred to the comparison model in the column, while a negative statistic value in the table that is less than -1.64 suggests that the model in the column is statistically preferred to the comparison model in the row. If the statistic value in the table lies between -1.64 and 1.64, then the two models being compared are statistically indistinguishable. 2. **indicates that the two compared models can be statistically distinguished at the 5% level.

1.5.4 The Percentage Changes in Markups Based on the Selected Supply Models

During the relevant merger and divesture periods, we now know which supply models best approximate price-setting behavior across each package size of milk products. During the merger period, in support of the DOJ's complaint against Dean Foods, we only find evidence of anticompetitive price-setting behavior for milk products in 16 ounces and 0.5 gallon package containers, respectively. However, it is interesting to learn the extent to which product price-cost markups are higher owing to anticompetitive price-setting behavior. Only for milk products in 1 gallon package containers during the divestiture period, we found that the milk products belonging to the divested brand are priced separately from the brands of milk products owned by Dean Foods, which is a price-setting outcome consistent with the objective of DOJ's divestiture policy decision. However, in an attempt to measure an impact of the DOJ's divestiture policy decision on the 1 gallon package size milk products, we compute the extent to which product price-cost markups would differ if the milk products that belong to the divested brand were cooperatively priced with the brands of milk products owned by Dean Foods.

Table 1.11 shows summary statistics on predicted percentage reductions in price-cost markups on products owned by Dean Foods during the merger period under the counterfactual scenario in which Dean Foods instead separately priced its newly acquired brands of milk products from its pre-existing brands of milk products. In case of milk products in 16 ounces package containers during the merger period, we report predicted reductions in price-cost markups based on counterfactual models with two distinct assumptions on the price-setting behavior of retailers, one in which retailers are active price-setters (Model 1) and the other in which they are passive (Model 3). The reason for using two distinct counterfactual models is that, for milk products in 16 ounces package containers during the merger period, the non-nested statistical tests could not statistically distinguish the two models of cooperative price-setting manufacturers (Model 2 and Model 4), where Model 2 assumes active price-setting retailers and Model 4 assumes passive retailers. The summary statistics in Table 1.11 reveal that the magnitudes of the percentage reductions in price-cost markups are all sufficiently small, less than 3%, if Dean Food's instead separately priced its newly acquired brands of milk products from its pre-existing brands of milk products, suggesting that anticompetitive effects should not be of concern.

Table 1.11: Predicted Percent Changes in Estimated Price-Cost Margins of Dean Food's Milk Products Based on Counterfactual Changes in Dean Food's Price-Setting Behavior during the Merger Period

	Active Price-setting Manufacturers, but Passive Retailers				Active Price-setting Manufacturers and Retailers			
	Mean	Std. Error	Min	Max	Mean	Std. Error	Min	Max
Size 1 (16 ounces)	-0.003%**	3.09E-06	-0.361%	0	-0.001%**	1.43 E-06	-0.163%	0
Size 3 (0.5 gallon)	-0.053%**	8.18E-06	-2.467%	0				

Notes: **indicates statistical significance at the 5% level.

Table 1.12 reports the extent to which product price-cost markups would differ if the milk products that belong to the divested brand were cooperatively priced with the brands of milk products owned by Dean Foods during the divestiture period. The summary statistics in the table show that under the counterfactual scenario in which the divested milk products are cooperatively priced with milk products owned by Dean Foods, then price-cost markups of milk products owned by Dean Foods will only increase by a mean 1.19%, with a maximum increase of 2.8%. Note that predicted changes in price-cost markups for the divested products may either increase or decrease, but the absolute magnitudes of predicted markup changes on these products are less than 1%. In summary, the predicted changes in price-cost markups are sufficiently small, suggesting that divestiture effects are negligible.

Table 1.12: Predicted Percent Changes in Estimated Price-Cost Margins of Milk Products Owned, as Well as Products Divested, By Dean Foods during the Divestiture Period, where Predicted Percent Changes are Based on Counterfactual Changes in Price-Setting Behavior across These Products

		Active Price-setting Manufacturers, but Passive Retailer			
		Mean	Std. Error	Min	Max
Size 4 (1 gallon)	Dean Foods' currently owned products	1.185%**	5.228E-04	0.315%	2.838%
	Dean Foods' divested products	0.101%**	2.635 E-04	-0.506%	0.634%

Notes: **indicates statistical significance at the 5% level.

1.6 Conclusion

On April 1, 2009, Foremost Farms sold two of its dairy processing plants to Dean Foods. The DOJ filed an antitrust suit on January 22, 2010 against Dean Foods with the purpose to disassemble the acquisition. DOJ's complaint argued that this acquisition eliminated an aggressive competitor of the sale of fluid milk against Dean Foods in certain markets. In July, 2011, the final judgment of this case required Dean Foods to divest one of the acquired plants. The paper examines two key issues of this case: (*i*) whether there exists evidence of anticompetitive price-setting behavior in support of the DOJ's complaint against Dean Foods; and (*ii*) the effectiveness and impacts of DOJ's final order of divestiture.

During the period over which Dean Foods owned the newly acquired brands of milk, the merger period, we find evidence of anticompetitive price-setting behavior in support of the DOJ's complaint against Dean Foods for milk products in 16 ounces and 0.5 gallon package containers, respectively. However, for milk products in 32 ounces and 1 gallon package containers, the evidence is not supportive of Dean Food's price-setting behavior being anticompetitive during the relevant merger period.

To comply with the DOJ's order, Dean Food's sold the Waukesha plant to Open Gates Capital Cooperation. As such, beginning in January 2012, milk products with the brand name

"Golden Guernsey", produced by the Waukesha plant, were owned by Open Gates Capital Cooperation instead of Dean Foods. In the IRI dataset, milk products with the brand name "Golden Guernsey" only exist in the package sizes of 0.5 gallon and 1 gallon. In case of milk products in 0.5 gallon package containers, we do not find any statistically significant evidence of a difference between market equilibrium outcomes if the divested products are cooperatively versus non-cooperatively priced with Dean Food's own products. Therefore, for milk products in 0.5 gallon package containers, there is no evidence that DOJ's divestiture policy decision had a statistically significant impact on the market. However, for milk products in 1 gallon package containers during the divestiture period, the evidence of non-cooperative price-setting behavior across the divested brand of milk products and brands of milk products owned by Dean Foods is consistent with the objective of the DOJ's divestiture policy decision.

In light of the evidences described above, the paper also examines the extent to which product price-cost markups would differ in the absence of anticompetitive price-setting behavior during the merger period. Furthermore, in order to provide a measured impact of the DOJ's divestiture policy decision on milk products in 1 gallon package containers, we compute the extent to which product price-cost markups would differ if the milk products that belong to the divested brand were cooperatively priced with the brands of milk products owned by Dean Foods during the divestiture period. We find that the magnitudes of the percentage reductions in price-cost markups are all sufficiently small, less than 3%, if Dean Food's instead separately priced its newly acquired brands of milk products from its pre-existing brands of milk products, suggesting that anticompetitive effects should not be of concern. Second, under the counterfactual scenario in which the divested milk products are cooperatively priced with milk products owned by Dean Foods, then price-cost markups of milk products owned by Dean Foods will only increase by a mean 1.19%, with a maximum increase of 2.8%. Furthermore, predicted changes in price-cost markups for the divested products may either increase or decrease, but the absolute magnitudes of predicted markup changes on these products are less than 1%. As such, the predicted changes in price-cost markups are sufficiently small, suggesting that divestiture effects are negligible.

Chapter 2- The Organic Food Price Premium and its Susceptibility to News Media Coverage: Evidence from the U.S. Milk Industry

2.1 Introduction

Consumer demand for organic food has been growing very fast in recent years. According to Organic Trade Association (OTA), the U.S. sales of organic food increases from $17 billion in year 2007 to $44 billion in year 2016. The annual growth rate of organic food sales reaches 8.4 percent in 2016, handily outpacing the stagnant 0.6 percent grow rate of overall U.S. food market sales. The organic sector now accounts for almost 5.3 percent of total food sales in United States, and its market share is expected to continue to expand over the next few years.

The burgeoning consumer interest in organic food, and big market opportunities it has opened, urge economic researchers to study the driving forces behind this growing segment of markets. There are a variety of reasons for the popularity of organic food, one explanation is that more and more consumers become aware of the benefits of eating organic food. Compared with conventionally-grown food, organic food is grown or processed with less or no use of pesticides, antibiotics and growth hormones. "People with allergies to foods, chemicals, or preservatives often find their symptoms lessen or go away when they eat only organic foods. Besides, organic farming practices are better for the environment as they reduce pollution, conserve water and increase soil fertility" (Robinson et al., 2018). As people learn more about the benefits of consuming organic food on health as well as the environment, they are more likely to purchase from the organic sector. Furthermore, consumers' perception of the marginal quality difference between organic and conventional products allow firms to charge a price premium associated with the perceived quality difference.

In this paper, we address the question of how the quantity of media coverage on organic-related issues impacts the price premium associated with the perceived quality difference between organic and conventional milk. Milk is a major consumer product in the US and 54 percent of Americans use it as a high quality protein source. In traditional milk production, a genetically engineered hormone, rBGH, is injected into cows to increase the production. This issue, which is widely reported by mainstream media and press, raises consumers' concerns about the safety of conventional milk and often steer them to healthier options, such as organic milk. As such, we are not surprised by the finding that "People who don't buy any other organic products are purchasing organic milk" (DuPuis 2000). However, there has been different voices in the media about organic milk. For instance, an investigative report published by Washington Post points out some 'organic' milk may not actually be organic at all. The Post reporter visited Colorado's Aurora Organic Dairy in 2016 and found that cows were not grazing in accordance with USDA organic standards. The organic milk produced in that facility, after put through a battery of chemical tests, was not dramatically different from conventional milk. These ongoing debates in media sources makes organic milk an interesting setting to study the influence of information dissemination on consumer shopping behavior, and the extent to which firms are able to exploit such shopping behavior as measured by an organic price premium.

We first use a theoretical model to illustrate how media information may influence the price premium associated with consumer's perception of the marginal difference between organic and conventional attributes of milk products. It provides a theoretical foundation for the subsequent empirical analysis in which we use milk sales and media data to estimate the relationship between consumers' willingness to pay for the organic feature of milk products and the intensity of organic-related news coverage.

The empirical analysis comprises two steps. In the first step, we estimate a random utility discrete choice model (Nevo 2003) to quantify consumers' time-specific mean valuation of the organic feature of milk products. After controlling price, time, location and other product characteristics, our estimation shows that on average consumers are willing to pay more for a milk product if it is labeled as organic. To be precise, the average consumers' willingness to pay for the organic feature of milk products is a mean \$1.19/gallon, which corresponds to 19.07% of the mean price per gallon of organic milk. We interpret the \$1.19/gallon as the average organic milk price premium. In the second step of the empirical analysis, we study how time-varying intensity of media coverage of organic milk affects consumers' time-varying willingness to pay for the organic feature of milk. We combine the estimates of consumer valuation of the organic feature of milk with media information data collected from LexisNexis Academic, and find that different media sources exhibit different effects on consumer valuation. More newspaper coverage significantly increases consumers' willingness to pay for the organic feature of milk, but this impact follows an inverted-U curve with a diminishing marginal effect. TV and Radio news coverage are not found to have a significant effect on consumer valuation of the organic feature of milk.

This paper joins the general literature studying the impacts of information disclosure on consumer food choices. Many studies in this literature focus on health or nutrition labelling, a policy which is widely-used by states and federal governments to promote healthier food, and examine its impact on consumer behavior (Ippolito and Mathios 1995, Mathios 2000, Ippolito and Pappalardo 2002, Jin and Leslie 2003, Teisl and Roe 1998, Teisl, Bockstael and Levy 2001, Teisl, Roe and Hicks 2002). For example, Jin and Leslie (2003) show that a policy by LA County which requires restaurants to display hygiene grade cards causes consumers to become sensitive to restaurant hygiene and reduces the incidence of foodborne illness hospitalizations. Teisl, Roe and Hicks (2002) find that the dolphin-safe label increased the market share of canned tuna. Among this stream of studies, there are studies which are specifically centered on organic fluid milk market. Kiesel, Buschena and Smith (2005) indicate that voluntary labeling of the use of rBGH in retail fluid milk increases consumer demand for rBGH-free milk and the estimated effects appear to have increased over time. Kiesel and Villas-Boas (2007) show that USDA organic seal increases the probability of purchasing organic milk.

Aside from examining the impacts of labeling policies, there are also studies analyzing consumer responses to food-related information circulated in various media sources. Shimshack, Ward, and Beatty (2007) use both parametric and non-parametric methods to examine consumer response to a national FDA advisory to limit store-bought fish consumption due to the dangers of methyl-mercury. They find education and newspaper readership are important determinants of consumer response. Schlenker and Villas-Boas (2009) study the reactions of consumer buying habits and financial markets to two health warnings about mad cow disease: The first discovery of an infected cow in December 2003 as well as health warnings about the potential effects aired in the highly-watched Oprah Winfrey show seven years earlier. They find a sharp drop in beef consumption and cattle futures following both warnings. Using a differences-in-differences empirical analysis, Kiesel (2012) shows average increases of 5% in organic milk sales relative to conventional milk sales during weeks for which news coverage on organic food production is observed. A key difference of our research from Kiesel (2012) lies in that we first use a structural random utility discrete choice model to directly estimate consumers' time-specific mean valuation of the organic feature of milk products, and then recover how this time-specific mean valuation is influenced by the intensity of media coverage of organic-related news.

The chapter proceeds as follows. In the next section, we present a theoretical model to lay the theoretical foundation for the subsequent empirical analysis. Section 2.3 describes the data used for analysis. Section 2.4 outlines the empirical model and estimation procedure used to analyze the media coverage effect on consumers' willingness to pay for the organic attribute of milk. Results are presented and discussed in Section 2.5, and section 2.6contains conclusion remarks.

2.2 Theoretical Insights

We use a theoretical model to show that media information may influence the price premium associated with consumer's perception of the marginal difference between organic and conventional attributes of milk products. Consider duopoly competition between two single-product firms: one firm sells one-gallon package size of organic milk, while the other firm sells conventional milk of the same package size. Therefore, we make the simplifying assumption that the two milk products are differentiated only by their organic/conventional feature. A consumer's indirect utility obtained from purchasing one unit of product j is given by:

$$u_j = \theta q_j - p_j \tag{2.1}$$

where $j = \{organic\ (o); conventional\ (c)\}$ denotes the type of milk; q_j measures the consumer's perceived quality of milk product j; and p_j represents the price of milk product j. θ represents consumer's preference for quality, which we assume is a random draw from a uniform distribution on $[0,1]$. The closer a consumer's draw of θ is to 1, the more the consumer values quality of the milk product.

Suppose $q_o \geq q_c$, that is, a consumer perceives organic milk of higher quality than the conventional one. A consumer chooses organic milk if her preference θ satisfies $\theta \geq \frac{p_o - p_c}{q_o - q_c}$. The demands for organic and conventional milk are respectively:

$$D_o(p_o, p_c; q_o, q_c) = 1 - \frac{p_o - p_c}{q_o - q_c} \quad and \quad D_c(p_o, p_c; q_o, q_c) = \frac{p_o - p_c}{q_o - q_c} \tag{2.2}$$

and the variable profit functions of the two firms are:

$$\pi_o = D_o(p_o, p_c; q_o, q_c)\,(p_o - c_o) \quad and \quad \pi_c = D_c(p_o, p_c; q_o, q_c)\,(p_c - c_c) \tag{2.3}$$

where c_j is the pre-unit cost of type-j milk. We assume $c_o > c_c$ based on the fact that production of organic milk has to comply with more stringent standards. Firms non-cooperatively and simultaneously choose price, p_j , to maximize their own profit. Nash equilibrium prices are:

$$p_o^* = \frac{2(q_o - q_c)}{3} + \frac{2c_o + c_c}{3} \quad and \quad p_c^* = \frac{q_o - q_c}{3} + \frac{c_o + 2c_c}{3} \tag{2.4}$$

Therefore, the theoretical model yields the following expression for the difference in equilibrium prices of organic and conventional milk:

$$p_o^* - p_c^* = \frac{(q_o - q_c)}{3} + \frac{(c_o - c_c)}{3} \tag{2.5}$$

Equation (2.5) reveals that the difference in equilibrium prices of organic and conventional milk depends on two key components: (*i*) the difference in consumer's perception of the attributes of organic and conventional milk products, $(q_o - q_c)$; and (*ii*) the difference in marginal cost of producing the two type of milk products, $(c_o - c_c)$. We define the organic price premium as the portion of the equilibrium price difference attributable to consumer's perception of the marginal difference between organic and conventional attributes of milk products. In other words, in equation (2.5) the organic price premium is captured by $\frac{(q_o - q_c)}{3}$.

The consumer's perceived quality difference between organic milk and conventional milk, $(q_o - q_c)$, is influenced by the intensity of media coverage of organic milk according to the following function:

$$q_o - q_c = g(f_o) \tag{2.6}$$

where f_o is a measure of the intensity of news coverage (perhaps measured by news item counts) about organic milk. Note that the slope and curvature properties of function $g(\cdot)$ determine the impact of relevant news media coverage intensity on consumer's perceived quality difference between organic and conventional milk products. The first-order derivative, $g'(\cdot)$, can either be positive or negative, depending on the stance the news takes about organic milk, and how a consumer interprets the news. Furthermore, equations (2.5) and (2.6) reveal that the impact of the intensity of news media coverage on the organic price premium is captured by the following derivative:

$$\frac{\partial\left[\frac{(q_O-q_C)}{3}\right]}{\partial f_O} = \frac{1}{3}g'(f_o) \tag{2.7}$$

The theoretical model reveals that the impact of the intensity of news media coverage on the organic price premium, $\frac{\partial\left[\frac{(q_O-q_C)}{3}\right]}{\partial f_O}$, directly depends on the impact of the intensity of news media coverage on consumer's perceived quality difference between organic and conventional milk, $g'(f_o)$. A key objective of the subsequent empirical analysis is to use data on consumer's purchases of organic and conventional milk products to first generate dollar value time-varying estimates of consumers' perceived quality difference between organic and conventional milk products, i.e., dollar value time-varying estimates of $(q_o - q_c)$. Dollar value time varying estimates of $(q_o - q_c)$ are effectively time-varying estimates of consumers' willingness to pay (WTP) for the organic feature of milk products. We then use a secondary estimator to recover how the time-varying intensity of news media coverage on organic milk influences the dollar value time-varying estimates of consumers' perceived quality difference between organic and conventional milk products, which effectively reveals $g'(f_o)$ and $\frac{\partial\left[\frac{(q_O-q_C)}{3}\right]}{\partial f_O}$.

2.3 Data

The empirical analysis uses Information Resources Inc. (IRI) retail point-of-sale scanner data. Information Resources Inc. is a Chicago-based marketing firm that uses scanning devices to collect point-of-sale retail data across 50 geographically distinct markets located in the United States. Fluid milk is one of the 30 product categories covered by IRI data, and is the product category of interest for this research. The point-of-sale data are weekly and compiled according to Universal Product Code (UPC) transactions in retail stores. Since one gallon is one of the most popular package sizes of fluid milk purchased weekly, we focus on this package size sold in 187 retail stores that are spread across 5 distinct IRI markets located in the states of Illinois, Michigan and Wisconsin. The period examined spans from January 2006 to December 2012. We define a product as the unique combination of non-price characteristics and retail store, where the measured non-price characteristics are: brands, type of milk (full lactose versus Soy milk), flavor, fat content, organic versus non-organic classification, and package type materials.

Milk consumption is measured by monthly aggregate quantity of each uniquely defined product purchased in a retail store within IRI markets. For each product, price is computed as the average revenue (in dollars per gallon) obtained from sales of the uniquely defined product during the relevant month.

For dairy processors, electricity is a major input in the production of fluid milk suitable for the retail market. Electricity is intensively used in the processing of fluid milk due to need for water heating, cooling and refrigeration. As such, to capture a measurable determinant of production cost, we collected state level industrial electricity price data from U.S. Energy Information Administration. All price data are deflated by the consumer price index (index base year Jan 2008 =100).

Several non-price product characteristic zero-one dummy variables were constructed to facilitate the empirical analysis. Table 1 reports summary statistics on product characteristic variables used in the empirical analysis. One of the product characteristic dummy variables relates to milk type, where the two milk types in our data set are full lactose and soy. Specifically, the variable takes the value one if the milk is full lactose (92.55% of the milk products), but zero if the milk is soy (7.45% of the milk products). There are three types of milk flavor in the dataset, 92.55% of which is the regular white milk, followed by the flavor of vanilla (1.28%), and original (6.17%). We classify the fat content of dairy milk into two categories, whole milk (44.36% of the milk products) and non-whole milk. In addition, we put plant-based milk products, such as soy milk, into the fat content category of non-whole milk.

There is no single variable in the IRI dataset that is constructed with the purpose of identifying milk products that are organic. As such, in order to identify organic milk products in the data we examine variables with various descriptive information on each product and classify the relevant product as organic if: (1) the brand description includes the word "organic"; or (2) the process description includes the phrases, "organic", "organic homogenized", "organic pasteurized", "organic ultra-pasteurized", or "organic pasteurized and homogenized". Based on this organic classification methodology we then constructed a zero-one dummy variable that takes a value of one only when the relevant product is classified as "organic". Organic milk products account for 20.08% of the milk products in our sample.

Since materials used for making milk containers differ, we create a set of dummy variables to capture the range of container materials. Plastic, Carton and glass account for 92.37%, 7.53% and 0.10% of the container packages, respectively. Consumer demographic information, such as income and age, are drawn from Public Use Microdata Sample database (PUMS).

We assume that consumers learn information about organic dairy from the mass media. Although organic milk has been available for more than two decades, the sales of organic milk have become one of the fastest growing market segments as consumers who do not buy any other organic products are purchasing organic milk (DuPuis 2000). It is argued that the rapid and impressive rise in the sales of organic milk is linked to mainstream media coverage on the use of rBGH in cows to increase milk production (DuPuis 2000). To retrieve the volume of information related to organic dairy, we keyword search news and transcripts related to organic dairy on LexisNexis Academic database. LexisNexis Academic database provides access to more than 3,000 worldwide newspapers, the transcripts from TV and radio and the legal and business research sources. We consider all national and local newspapers, as well as TV and radio transcripts to measure the volume of media coverage related to organic dairy. The numbers of searched-recovered articles or transcripts within each period are used as time-varying measures of information intensity.

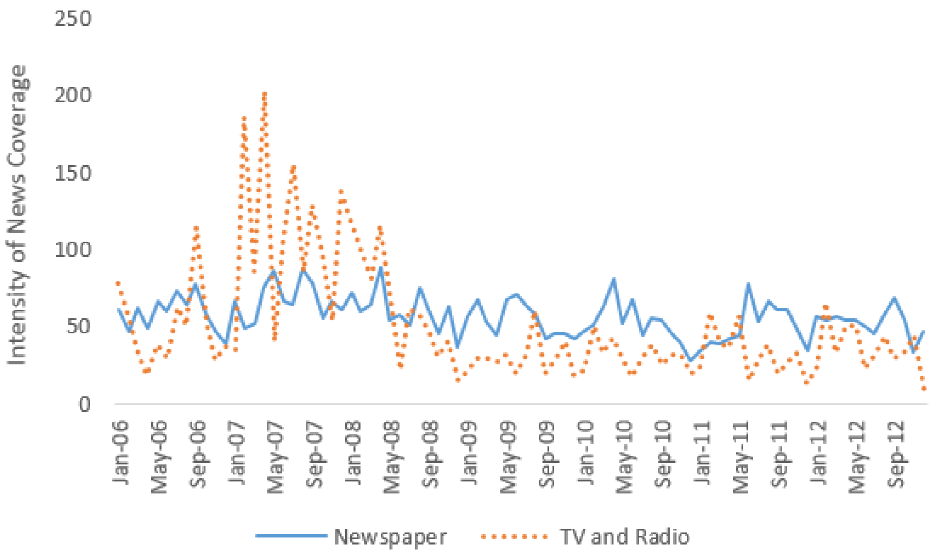
Table 2.1: Summary Statistics

Description	Milk Size (128 ounces = 1 gallon) Mean	Standard deviation	Min	Max	Obs
Real Milk Price (dollars per gallon)[1]	4.0205	1.4562	0.9786	10.3600	45,267
Mean Personal Income(dollars per year)	36,042.13	3823.19	24806.06	41743.07	45,267
IRI Market Population (per year)	5,239,710	3,513,091	96,527	9,108,058	45,267
Age	45.2451	18.0210	15	95	45,267
Real Electricity Price (cents per kWh)	6.1889	0.8065	4.2471	7.8745	45,267
Milk Type Dummy Variables:					
Full Lactose Milk	0.9255	0.2626	0	1	45,267
Soy Milk	0.0745	0.2626	0	1	45,267
Flavor Type Dummy Variables:					
Regular White	0.9255	0.2626	0	1	45,267
Vanilla	0.0128	0.1125	0	1	45,267
Original	0.0617	0.2406	0	1	45,267
Fat Content Dummy (=1 if whole milk)	0.4436	0.4968	0	1	45,267
Oragnic milk Dummy (=1 if organic)	0.2008	0.4006	0	1	45,267
Package Type Dummy Variables:					
Carton Package	0.0753	0.2639	0	1	45,267
Plastic Package	0.9237	0.2655	0	1	45,267
Glass Package	0.0010	0.0322	0	1	45,267
Media Coverage Data					
Number of organic-related news items reported in Newspapers (counts per month)	56.63	12.99			
Number of organic-related TV and Radio transcripts (counts per month)	50.38	37.98			

1. Prices to real dollars using the Consumer Price Index, with 2008 as the base year.

Table 2.1 also reports summary statistics of the organic dairy-relevant news coverage data from Newspapers, TV and radio. As shown in Table 1, the average number of organic dairy news articles from newspapers is 56 per month, and the average number of TV and radio transcripts per month related to organic dairy is about 50. Figure 2.1 shows a time series plot of the intensity (measured by articles and transcripts counts) of news media coverage on organic dairy from newspapers, and TV and radio. It is evident that the intensity of media coverage is relatively volatile overtime with a slight upward trend in intensity of TV and radio coverage prior to May 2008.

Figure 2.1: Intensity of Organic Dairy News Coverages from Newspapers, TV and Radio over Time



2.4 The Empirical Models

2.4.1 Demand of Differentiated Products

We model the demand for fluid milk using a random coefficients logit model (Berry, Levinsohn and Pakes 1995, Nevo 2000 and 2001). Incorporating consumer demographics into the random coefficients logit model allows us to account for consumers' taste heterogeneity for product attributes, thus enabling more accurate computation of consumers' willingness to pay for the organic attribute.

The indirect utility consumer i obtains from purchasing milk product j in market t is specified as:

$$U_{ijt} = x_{jt}\beta_i + \omega_i Organic_{jt} + \alpha_i p_{jt} + \rho_{year} + \tau_{month} + \gamma_{market} + \xi_{jt} + \varepsilon_{ijt} \quad (2.8)$$

where x_{jt} is a vector that includes several measured non-price product characteristics with the exception of the organic characteristic; and β_i is the vector of consumer-specific taste parameters, i.e., marginal utilities, associated with the corresponding product characteristic variables in x_{jt}. $Organic_{jt}$ is a zero-one dummy variable that equals to one only if milk product j is classified as organic; and ω_i is a consumer-specific taste parameter which measures the consumer's valuation of the organic characteristic of milk relative to the product being non-organic. Note that $(q_o - q_c)$ in the simple theoretical model specified earlier, is effectively measured by ω_i in this more flexible empirical random utility model. p_{jt} is the price of product j in market t; and α_i is the consumer-specific taste parameter that measures the consumer's marginal utility of price. ρ_{year}, τ_{month} and γ_{market} represent fixed effect controls for year, month, and geographic location of IRI market respectively. ξ_{jt} represents product characteristics that are unobserved by us the researchers, but observed by consumers; and ε_{ijt} represents the random component of utility that is assumed independent and identically distributed across consumers, products and markets.

The random coefficients α_i, β_i and ω_i are allowed to vary across consumers according to:

$$\begin{pmatrix} \beta_i \\ \omega_i \\ \alpha_i \end{pmatrix} = \begin{pmatrix} \beta \\ \omega \\ \alpha \end{pmatrix} + \Gamma D_i + \Sigma v_i \quad (2.9)$$

where D_i is an m-dimensional column vector of demographic variables (assuming there are m distinct demographic variables), and each demographic variable enters the vector in the form of deviation of individual i's demographic variable from the mean of the market sample of individuals; Γ is a L-by-m dimension matrix of parameters (L is the number of random taste parameters in $\begin{pmatrix} \beta_i \\ \omega_i \\ \alpha_i \end{pmatrix}$), where the parameters measure how taste characteristics vary with demographics; v_i is a L-dimensional column vector of unobserved shocks to consumer taste for respective product characteristics; and Σ is a L-by-L diagonal matrix, where elements on the main diagonal are parameters that measure variation in taste due to the random shocks in v_i.

In the demand estimation, demographic variables in D_i are income and age. Since variables in D_i enter in deviations from mean, the mean of each variable in D_i is zero. Following Nevo (2000), we assume that v_i has a standard multivariate normal distribution, $v_i \sim N(0, I)$. Given that the mean of D_i and v_i each equal to zero, then the mean of $\begin{pmatrix} \beta_i \\ \omega_i \\ \alpha_i \end{pmatrix}$ is $\begin{pmatrix} \beta \\ \omega \\ \alpha \end{pmatrix}$ and the variance is equal to the square of the elements on the main diagonal of Σ.

The mean utility across consumers obtained from consuming product j in market t, δ_{jt}, is given by:

$$\delta_{jt} = x_{jt}\beta + \omega Organic_{jt} + \alpha p_{jt} + \rho_{year} + \tau_{month} + \gamma_{market} + \xi_{jt} \tag{2.10}$$

Consumer-specific deviations from the mean utility is given by:

$$\mu_{ijt} = \left(x_{jt} \;\; Organic_{jt} \;\; p_{jt}\right) \times (\Gamma D_i + \Sigma v_i) \tag{2.11}$$

Therefore, as in Nevo (2000), the indirect utility consumer i obtains from purchase of product j in market t in equation (2.8) can be rewritten in terms of mean utility obtained across all consumers in the market, and consumer i's deviation from the mean utility, that is,

$$U_{ijt} = \delta_{jt} + \mu_{ijt} + \varepsilon_{ijt} \tag{2.12}$$

where δ_{jt} is the mean utility, and $(\mu_{ijt} + \varepsilon_{ijt})$ is the consumer-specific deviation from the mean utility. The consumer-specific utility deviations capture heterogeneous preferences across consumers, but these deviations by construction and assumptions have a mean of zero.

The specification of the demand model is completed with the inclusion of an outside option/good denoted by good zero. The outside good allows for the possibility that consumer i may not purchase any of the products in a given market, and the mean utility of the outside good is normalized to be zero and constant over time. The indirect utility from this outside option is $U_{i0t} = \varepsilon_{i0t} = 0$. Assuming that ε_{ijt} is independent and identically distributed with an extreme value type I density, the predicted market share of product j in market t is given by

$$s_{jt} = \int_{A_{jt}} \left(\frac{\exp(\delta_{jt}+\mu_{ijt})}{1+\sum_{l=1}^{J} \exp(\delta_{lt}+\mu_{ilt})} \right) d\hat{F}(D) \mathrm{d}\Phi(v_i) \tag{2.13}$$

where A_{jt} represents the set of consumers who choose product j in market t, $\hat{F}(D)$ is the empirical distribution of demographic variables (income, age, etc.) in the market, and $\Phi(\cdot)$ is the standard normal distribution function. Since there is no closed-form solution for the integral in equation (2.13), this integral must be approximated numerically using random draws from $\hat{F}(D)$ and $\Phi(\cdot)$.[11]

Based on the discrete choice model above, the demand for product j in market t is simply given by:

$$d_{jt} = s_{jt}\left(x_{jt}, Organic_{jt}, p_{jt}, \xi_{jt}; \Theta\right) \times M_t \tag{2.14}$$

where Θ is the vector of demand parameters to be estimated, and M_t is a measure of the potential market size of market *t*. Specifically, $\Theta = (\theta_1, \theta_2)$, where $\theta_1 = (\beta, \omega, \alpha, \rho, \tau, \gamma)$ and $\theta_2 = (\Gamma, \Sigma)$.

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[11] We use 300 random draws from $\hat{F}(\cdot)$ and $\Phi(\cdot)$ for the numerical approximation of $s_{jt}(\cdot)$. Consumer demographic information, such as income and age, are randomly drawn from Public Use Microdata Sample database (PUMS).

We construct the potential market size measure, M_t, in each market using the following procedure. First, we obtained data on annual per capita dairy fluid milk consumption from United States Department of Agriculture Economic Research Service (USDA ERS).[12] Since USDA ERS per capita dairy fluid milk consumption data are measured in liquid pounds, we converted the unit of measurement of these data to gallons, and divide by 12 to obtain average monthly per capita consumption of dairy fluid milk in gallons. Second, even though we were not able to obtain per capita consumption of soy milk directly, we sourced data on annual total sales of soy milk in gallons,[13] and divide these unit sales data by population size to obtain average annual per capita soy milk consumption. We then convert these average annual per capita soy milk consumption data to average monthly per capita soy milk consumption. Third, monthly per capita milk (dairy and soy) consumption is obtained by summing monthly per capita consumption of dairy fluid milk and soy milk. Last, potential market size measure, M_t, in each market is computed by using the population size of the relevant geographic market multiplied by monthly per capita milk consumption.

2.4.2 Demand Estimation and Instruments

Parameters of the demand model are estimated using Methods of Simulated Moments (MSM) algorithm outlined in Nevo (2000). We construct the MSM estimator by using instrumental variables that are orthogonal to product characteristics captured in ξ_{jt} that are unobserved to us but observed by firms and consumers. Instrumental variables for the product price of milk are needed because it is likely that ξ_{jt} is correlated with milk price.

The variables used to instrument milk price are state-level electricity price for the industrial sector interacted with milk brand dummies. It is reasonable to assume that an input

[12] https://www.ers.usda.gov/data-products/dairy-data/
[13] https://www.statista.com/statistics/552967/us-soy-milk-sales/

price such as electricity price is uncorrelated with ξ_{jt}, but highly correlated with milk price. For example, an unmeasured product-specific characteristic such as brand loyalty is most likely uncorrelated with state-level electricity price, but changes in the price of electricity would definitely influence milk prices. In fact, in year 2006 the electricity consumption in dairy industry accounted for nearly 13% of the entire food industry electricity usage (U.S. DOE 2006b). Furthermore, electrical energy use is increasing as milk manufacturers become highly automated. The underlying intuition to interact the electricity price with milk brand dummies is to capture the likelihood that different milk products differentially uses electricity to arrive at the final milk product purchased by consumers, which in turn suggests that changes in electricity price should differentially affect final milk product prices. For example, the brand "Silk" focus on soy milk production, which is likely to consume less electricity than processing cow's milk. Another example is that the shelf life of organic milk is longer than conventional milk, because organic milk usually undergoes ultra-high temperature (UHT) processing or treatment, and conventional milk generally uses a standard preservation process. UHT requires higher electricity consumption, as such, electricity usage required by the production process is different across organic milk brands and conventional milk brands. Yet another example in which electricity usage required by the production process likely differ across various milk brand products is based on the fat content present in the final milk product. Monthly state-level electricity price for the industrial sector are collected from U.S. Energy Information Administration.

2.4.3 Measurement of Consumer Choice Behavior

The primary objective of this paper is to evaluate if more media coverage related to organic dairy in newspapers, and on TV and radio influence the organic milk price premium, or equivalently, influence consumers' willingness to pay (WTP) for the organic attribute of milk. From the demand estimation we can obtain an estimate of the average consumer's WTP for the organic attribute by dividing the estimate of the parameter on the organic dummy variable, ω, by the estimate of the parameter on price, α, i.e. $WTP_t = \frac{\omega_t}{\alpha}$, where ω_t is a time-specific estimate of the parameter on the organic dummy variable. We then apply a minimum-distance estimation procedure discussed in Nevo (2000) to recover how time varying counts of media coverage related to organic dairy in newspapers, and on TV and radio influence WTP_t. The minimum-distance estimation procedure effectively implements a feasible generalized least squares estimator of the following equation:

$$WTP_t = \phi_0 + \phi_1 WTP_{t-1} + \phi_2 I_t^{np} + \phi_3 \left(I_t^{np}\right)^2 + \phi_4 I_t^{tr} + \phi_5 (I_t^{tr})^2 + \varepsilon_t^{wtp} \quad (2.15)$$

where WTP_t is our demand model estimate of consumers' willingness to pay for the organic attribute of milk during period *t*; I_t^{np} measures the number of organic dairy news articles from newspapers during period *t*; I_t^{tr} measures the number of organic dairy news transcripts from TV and radio during period *t*; and ε_t^{wtp} is a mean zero random error term that is a composite of non-media influences on consumers' time-specific willingness to pay for the organic attribute of milk.

There are two features of the WTP_t equation specification that are worth pointing out. First, we allow the WTP_t equation to capture the possibility that consumers' current period's willingness to pay for the organic attribute of milk is in part influenced by their previous period's willingness to pay, thus capturing potential persistence in consumers' willingness to pay for the organic attribute of milk. Persistence in consumers' willingness to pay for the organic attribute of milk may exist due to their preferences being rooted in a history of relevant information. Second, I_t^{np} and I_t^{tr} enter the WTP_t equation in quadratic form, i.e. $\left(I_t^{np}\right)^2$ and $(I_t^{tr})^2$ are right-hand-side variables, which enable the specification to capture the possibility of declining marginal effect of news media information intensity on consumers' current period's willingness to pay for the organic attribute of milk. In other words, it is reasonable to hypothesize that as the volume of news media information increases during a given period, the marginal impact of additional news media information on consumers' willingness to pay becomes less.

2.5 Econometric Estimation and Inferences

We first present and discuss the demand estimation results, which include estimates of the average consumer's WTP for the organic attribute of milk. We then present and discuss estimation results on the relationship between consumer's WTP for the organic attribute of milk and the intensity of news media coverage related to organic dairy.

2.5.1 Results of Demand Estimation

Demand model parameter estimates are reported in Table 2.2. The second and third columns in the table report ordinary least squares (OLS) and two-stage least squares (2SLS) estimation results of the standard logit version of the demand model, while the other columns report method of simulated moments (MSM) estimation results of the random coefficients logit version of the demand model. Consistent with economic theory, the OLS and 2SLS coefficient estimates on price are negative and statistically significant. However, a Wu-Hausman test is performed to examine the endogeneity of price, and the result of this test, which is also reported in the table, provides strong evidence that price is endogenous. As such, instruments are needed for price. The remainder of the discussion focusses on results from the random coefficients logit version of demand model rather than the standard logit version since the random coefficients logit is better able to capture heterogeneity in consumers' preferences.

The negative and statistically significant coefficient on price reveals that, on average, consumers' level of utility is inversely related to the price of the product. As such, consistent with expectation, if non-price product characteristics across competing products are equal, then our estimated price effect suggests that consumers will choose the milk product that has the lower price.

The coefficient estimate on the soy milk dummy variable is positive and statistically significant, suggesting that after controlling for other factors that may influence milk demand, the average consumer obtains higher utility by purchasing soy milk compared to dairy milk. The coefficient estimate on the fat content dummy variable is statistically insignificant at conventional levels of statistical significance, suggesting that, on average, consumers seem to be indifferent between whole milk and non-whole milk. The coefficient estimate on the milk flavor dummy variable is negative and statistically significant, suggesting that compared with vanilla flavor, consumers prefer regular white milk and original milk. The vanilla flavoring added to milk can either be artificial or real, and vanilla extract often contains alcohol. As such, this result is consistent with argument that consumers may prefer to avoid milk products with added vanilla flavoring for health reasons. The statistically insignificant coefficient estimate on the container package material dummy variable, suggests that consumers are indifferent between milk package materials (plastic, glass or carton) when choosing between milk products.

The parameter estimates that capture taste heterogeneity across consumers are statistically insignificant at conventional levels of statistical significance. We may interpret these results as suggesting that heterogeneity across consumers does not play a significant role in explaining consumer choice behavior across various milk products. This narrative on the apparent inconsequential role that consumer heterogeneity plays in milk demand is not surprising since product differentiation across milk products is relatively small compared to many other industries.

The most important milk product attribute for this research is whether or not the product is organic. The coefficient estimate on the organic dummy variable is positive and statistically significant suggesting that, on average, consumers prefer organic milk products to other milk products.

Consumers' WTP for the organic attribute of milk is computed by dividing the coefficient estimate of the organic dummy variable by the price coefficient estimate. The division of these coefficient estimates suggest that the average consumer is willing to pay \$1.19/gallon extra for the organic attribute of milk products, which corresponds to 19.07% of the mean price per gallon of organic milk. In other words, parameter estimates from our demand model suggest that the average organic price premium for milk is \$1.19 per gallon.

Table 2.2: Results from Demand Model Estimation

	Standard Logit		Random Coefficients Logit			
Estimation method	OLS	2SLS	MSM			
Variables	Mean β	Mean β	Mean β	Standard Deviations σ	Interactions with Demographic Variables: Age	Interactions with Demographic Variables: Income
Panel A						
Real Milk Price	-46.8762**	-219.2512**	-219.1708**	-0.9254		-0.6994
	(0.8798)	(13.3530)	(24.8725)	(211.5801)		(59.8531)
Constant	-14.6920**	-6.5369**	-6.5361**	-0.0195		
	(0.4389)	(0.8666)	(1.2914)	(5.7693)		
Fat Content	-1.5001**	-1.3122**	-1.5386	0.6748	0.5572	
	(0.0089)	(0.0189)	(5.0515)	(7.5485)	(14.9429)	
Milk type: soy milk	4.1794**	6.5263**	6.5185**			
	(0.4306)	(0.6119)	(0.8090)			
Flavor: Vanilla	-0.0243	-0.2433**	-0.2426**			
	(0.0423)	(0.0599)	(0.0750)			
Package: Plastic	3.3937**	-0.0051	-0.0046			
	(0.1523)	(0.3340)	(0.4808)			
Organic	-1.7292**	2.0628**	2.6003**			
	(0.0330)	(0.3372)	(0.5487)			
Time fixed effects	YES	YES	YES			
Brand fixed effects	YES	YES	YES			
Retail store fixed effects	YES	YES	YES			
Market fixed effects	YES	YES	YES			
R^2	0.8726					
Wu-Hausman (χ^2)		311.703 (p-value = 0.0000)				
MSM Objective					0.0109	
Panel B						
Real Milk Price	-47.2352**	-228.0709**	-237.0716**	-7.8708		-0.7999
	(0.8991)	(13.5527)	(32.3602)	(36.8281)		(68.4076)
Constant	-14.7847**	-5.9703**	-6.4608**	0.7785		
	(0.4374)	(0.8860)	(1.2651)	(1.5107)		
Fat Content	-1.5011**	-1.2955**	-3.1124	1.9979	-1.0437	
	(0.0089)	(0.0196)	(2.7885)	(1.5448)	(5.4170)	
Milk type: soy milk	4.2554**	6.7418**	6.7972**			
	(0.4289)	(0.6177)	(0.7024)			
Flavor: Vanilla	-0.0311	-0.0680	-0.0602			
	(0.0426)	(0.0585)	(0.0667)			
Package: Plastic	3.4533**	-0.1300	-0.1628			
	(0.1519)	(0.3392)	(04303)			
Organic * time periods	YES	YES	YES			
Time fixed effects	YES	YES	YES			
Brand fixed effects	YES	YES	YES			
Retail store fixed effects	YES	YES	YES			
Market fixed effects	YES	YES	YES			
R^2	0.8738					
Wu-Hausman (χ^2)		341.257 (p-value = 0.0000)				
MSM Objective					0.0125	
Observations	45,267	45,267			45,267	

Note: All regressions include yearly dummies, monthly dummies, geographic market location dummies, brand dummies and retail store dummies. Standard errors are in parenthesis. *indicates statistical significance at the 10% level, **indicates statistical significance at the 5% level

To facilitate the next portion of our empirical analysis we need to obtain time-specific estimates of consumers' WTP for the organic attribute of milk. As such, we re-estimate a modified specification of the demand model, where the key modification is to replace the organic dummy variable with interactions of the organic dummy variable with 84 time period dummy variables. The results of this modified demand model estimation are shown in the lower panel (Panel B) of Table 2.2. Importantly, a comparison of the estimation results across Panel A and Panel B of Table 2.2 reveals that moving to time-specific controls of the organic attribute has not changed the qualitative results of the other demand variables previously discussed.

The coefficient estimates of the interactions of organic dummy with 84 time periods dummy variables are reported in the Appendix, and all of these coefficient estimates are positive and statistically significant at 5% level. These 84 coefficient estimates are divided by the coefficient estimate on price to obtain time period-specific estimates of consumers' WTP for the organic attribute of milk. Figure 2.2 plots the time period-specific estimates of consumers' WTP for the organic attribute of milk over the periods January 2006 to December 2012. The figure does show evidence of fluctuations in consumers' WTP for the organic attribute of milk. We now evaluate the extent to which these fluctuations are influenced by fluctuations in the intensity of media coverage on organic dairy issues.

Figure 2.2: Consumers' WTP for Organic Characteristic

2.5.2 Media Effects on Consumers' Willingness to Pay for the Organic Attribute of Milk.

Once time varying estimates of consumers' WTP for the organic attribute of milk are obtained, facilitated by equation (2.15), we use the minimum-distance estimation procedure outlined in Nevo (2000) to recover how the WTP estimates are influenced by fluctuations in the intensity of media coverage on organic diary issues. Table 2.3 reports parameter estimates of various restricted specifications of equation (2.15). The first column of Table 2.3 reports the most general specification of equation (2.15), which include measuring linear and quadratic impacts on WTP of the intensity of news media coverage of organic dairy information from both newspapers articles, and TV and radio transcripts.

From the second column of Table 2.3, we find evidence of a quadratic relationship between consumers' WTP for the organic characteristic and the intensity of media coverage on organic dairy issues from newspaper. Specifically, the coefficient estimates on newspaper article counts and the square of newspaper article counts suggest that each additional organic dairy newspaper article increases consumers' WTP for the organic characteristic up to a monthly article count of 56, but decreases consumers' WTP with each additional monthly article beyond 56 articles.[14] Within the news coverage intensity range in which each additional newspaper article on organic dairy issues has positive marginal effect on consumers' WTP for the organic characteristic, the estimated marginal effect is diminishing with each additional article, where the highest positive marginal effect is equivalent to an increase in WTP of 0.76 cents per gallon associate with the first article of the month. The second, fourteenth, twenty eighth, and forty second articles of the month increase consumers' WTP by 0.75, 0.58, 0.39, and 0.20 cents per gallon respectively.[15]

Table 2.3: Influence of Media Coverage on Consumers' WTP for the Organic Attribute of Milk

Dependent Variable: Consumers' time-specific WTP for the Organic Attribute of Milk			
	(1)	(2)	(3)
One period lagged dependent variable	0.0887**	0.1007**	0.0904**
	(0.0166)	(0.0163)	(0.0166)
Newspaper article counts	0.00769**	0.00761**	
	(0.00288)	(0.00288)	
TV and Radio transcripts counts	-4e-05		-5.3e-05
	(0.00060)		(0.00057)
Quadratic Newspaper article counts	-6.4e-05**	-6.8e-05**	
	(2.38e-05)	(2.38e-05)	
Quadratic TV and Radio transcripts counts	-3.7e-06		-3.7e-06
	(3.3e-06)		(3.23e-06)
Constant	-0.7469**	-0.7478**	-0.5497**
	(0.0960)	(0.0943)	(0.0614)
Number of observations	83	83	83

Notes: The data used for estimating regressions in this table are monthly time-series. The values of the dependent variable in these regressions are the time-specific willingness to pay estimates of the organic attribute of milk computed from parameter estimates from the discrete choice milk demand model. The regressions are estimated using feasible generalized least squares (FGLS). Standard errors are in parenthesis. *indicates statistical significance at the 10% level, **indicates statistical significance at the 5% level.

[14] The threshold newspaper article count of 56 is obtained by solving the following linear equation for Newspaper Article Count: 0.0076 – 2*0.000068 * (Newspaper Article Count) = 0, which yields Newspaper Article Count = 0.00761/2*(0.000068). Note that this linear equation used to solve for the threshold newspaper article count is derived from the regression estimates in column 2 of Table 3, by setting to zero the marginal effect of WTP with respect to Newspaper Article Counts.

[15] The estimated positive marginal effect of 0.75 cents per gallon for the second article is computed from the coefficients in column 2 as follows: [0.0076 – 2*0.000068 (1)] * 100. The marginal effects of 0.58 and 0.39 cents per gallon for the fourteenth and twenty eighth articles respectively, are computed from the coefficients as follows: [0.0076 – 2*0.000068 (13)] * 100 and [0.0076 – 2*0.000068 (27)] * 100, respectively.

The positive and statistically significant coefficient estimate on the lagged dependent variable provides evidence of habit persistence in consumers' willingness to pay for the organic characteristic of milk, i.e., consumers' current period's willingness to pay for the organic attribute of milk is in part influenced by their previous period's willingness to pay. We can also use the coefficient estimate on the lagged dependent variable to facilitate computing long-run marginal effects on consumers' willingness to pay for the organic characteristic of milk associated with each additional organic dairy newspaper article. For example, we stated above that the first newspaper article of the month increases consumers' WTP by 0.76 cents per gallon, but this is a short-run marginal effect estimate. Over the long-run the marginal effect on consumers WTP of the first newspaper article of the month is 0.84 cents per gallon, which is computed as follows: $[0.0076/(1 - 0.10)]*100$. Analogously, the long-run marginal effects on consumers' WTP of the second, fourteenth, twenty eighth, and forty second articles of the month are 0.83, 0.64, 0.43, and 0.22 cents per gallon respectively.

As evidenced in the first and third columns of estimates, we do not find a statistically significant impact of the number of transcripts on organic dairy issues from TV and radio on consumers' WTP for the organic attribute of milk. What media consumption patterns might explain the evidence that organic dairy information transmitted via newspaper impacts consumers' WTP for the organic attribute of milk, but similar information transmitted via TV and radio has no statistically discernable impact on consumers' WTP for the organic attribute of milk? According to the annual Jacobs Media Techsurvey,[16] the primary motivation for listening to AM/FM radio is to hear favorite songs, as 53.3% of the respondents cited this as the main reason to be radio listeners. Only 21.7% of the respondents stated that the main reason to listen AM/FM radio was to stay informed about the news, traffic or weather. According to

[16] Jacobs Media Techsurvey is based on the survey of more than 30,000 listeners in the U.S. https://jacobsmedia.com/techsurvey-12-results/
https://jacobsmedia.com/techsurveys-a-look-at-how-audiences-are-using-new-technologies/

the annual American Time Use Survey (ATUS), watching TV is the leisure activity that most occupied adults' leisure time. Among the top 250 TV programs in the U.S., 33% of the most popular programs are drama shows, followed by comedy (18%), participatory/reality (17%), news (15%) and sports (10%). Although the circulation of newspapers has been falling since 2003,[17] newspapers are still the critical part of the American news landscape. Therefore, since the main reason for listening to radio and watching TV is to be entertained rather than to be informed, such media consumption preference patterns are consistent with the evidence that organic dairy information transmitted via newspaper impacts consumers' WTP for the organic attribute of milk, but similar information transmitted via TV and radio has no statistically discernable impact on consumers' WTP for the organic attribute of milk.

2.6 Conclusion

Consumers' perception of the marginal quality difference between organic and conventional products allow firms to charge a price premium associated with the perceived quality difference. We refer to this price premium as the organic price premium. The organic price premium is equivalent to consumers' willingness to pay for the organic attribute. In this paper, we address the question of how the quantity of media coverage on organic dairy issues impacts the organic milk price premium.

We first use a theoretical model to illustrate how media information may influence the organic price premium, which provides a theoretical foundation for the subsequent empirical analysis in which we use milk sales and media data to estimate the relationship between consumers' willingness to pay for the organic feature of milk products and the intensity of organic-related news coverage.

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[17] Pew research center: http://www.journalism.org/chart/newspaper-circulation-falls-in-2014/

First, our empirical analysis reveals that, on average, consumers are willing to pay \$1.19/gallon more for the organic attribute of milk, which corresponds to 19.07% of the mean price per gallon of organic milk. In other words, we estimate that on average the organic price premium for milk products is approximately 29% of the price per gallon. Second, we find evidence of a quadratic relationship between consumers' WTP for the organic attribute of milk and the intensity of media coverage on organic dairy issues from newspaper. Specifically, each additional organic dairy newspaper article increases consumers' WTP for the organic characteristic up to a monthly article count of 56, but decreases consumers' WTP with each additional monthly article beyond 56 articles. Within the news coverage intensity range in which each additional newspaper article on organic dairy issues has positive marginal effect on consumers' WTP for the organic attribute, the estimated marginal effect is diminishing with each additional article, where the highest positive marginal effect is equivalent to an increase in WTP of 0.76 cents per gallon associate with the first article of the month. Interestingly, we do not find a statistically significant impact of the number of transcripts on organic dairy issues from TV and radio on consumers' WTP for the organic attribute of milk, which may be partly driven by survey evidence suggesting that consumers' main reason for listening to radio or watching TV is to be entertained rather than to be informed.

Last, we find evidence of habit persistence in consumers' willingness to pay for the organic characteristic of milk, i.e., consumers' current period's willingness to pay for the organic attribute of milk is in part influenced by their previous period's willingness to pay. Such habit persistence is likely influenced by, among other things, the history of news media coverage on organic dairy issues.

References

Berry, S. T. (1994). Estimating Discrete-Choice Models of Product Differentiation. *The RAND Journal of Economics*, *25*(2), 242-262.

Berry, S., Levinsohn, J., & Pakes, A. (1995). Automobile Prices in Market Equilibrium. *Econometrica*, *63*(4), 841-890.

Berry, S. T., & Haile, P. A. (2014). Identification in Differentiated Products Markets Using Market Level Data. *Econometrica*, *82*(5), 1749-1797.

Bonnet, C., & Dubois, P. (2010). Inference on vertical contracts between manufacturers and retailers allowing for nonlinear pricing and resale price maintenance. *The RAND Journal of Economics*, *41*(1), 139-164.

Bonnet, C., Dubois, P. & Villas-Boas, S.B. (2013). Empirical Evidence on the Role of Non-Linear Wholesale Pricing and Vertical Restraints on Cost Pass-Through. *The Review of Economics and Statistics*, *95*(2), 500-515.

Bonnet, C., & Mechemache, Z. B. (2015). Organic Label, Bargaining Power, and Profit-sharing in the French Fluid Milk Market. *American Journal of Agricultural Economics*, *98*(1), 113-133

Bonnet, C., Corre, T., & Réquillart, V., (2015). Price Transmission in Food Chains: The Case of the Dairy Industry, TSE Working Papers, 515-563

Bresnahan, T. F. (1989). Empirical studies of industries with market power. *Handbook of Industrial Organization*, *2*, 1011-1057.

Bronnenberg, B. J., Kruger, M. W., & Mela, C. F. (2008). “Database Paper: The IRI Marketing Data Set”. *Marketing Science*, *27*(4), 745-748.

Cai, X., & Stiegert, K. W. (2013). “Economic Analysis of The US Fluid Milk Industry”. *Applied Economics Letters*, *20*(10), 971-977.

Cakir, M., & Balagtas, J. V. (2012). “Estimating Market Power of U.S. Dairy Cooperatives in the Fluid Milk Market”. *American Journal of Agricultural Economics*, *94*(3), 647-658.

Cotterill, R. W., & Dhar, T. P. (2003). “Oligopoly Pricing with Differentiated Products: The Boston Fluid Milk Market Channel”. *IDEAS Working Paper Series from RePEc*. Retrieved from https://ideas.repec.org/p/ags/uconnr/25189.html#cites

Choi, H.-J., Wohlgenant, M. K., & Zheng, X. (2013). Household-level Welfare Effects of Organic Milk Introduction. *American Journal of Agricultural Economics*, *95*(4), 1009-1028

Dairy 100. (2009, August). Retrieved from https://www.dairyfoods.com/ext/resources/DF/Home/Files/PDFs/archives/d/df0809Dairy-100-table.pdf

Davis, C. G., Dong, D., Blayney, D., Yen, S. T., & Stillman, R. (2012). U.S. Fluid Milk Demand: A Disaggregated Approach. *International Food and Agribusiness Management Review*, *15*(1), 25-50.

Dhar, T., & Foltz, J. D. (2005). “Milk By Any Other Name ... Consumer Benefits From Labeled Milk”. *American Journal of Agricultural Economics*, *87*(1), 214-228.

DuPuis, E. M. (2000). Not in my body: rBGH and the rise of organic milk. *Agriculture and Human Values*, *17*, 285-295.

Gasmi, F., Laffont, J. J., & Vuong, Q. (1992). Econometric Analysis of Collusive Behavior in Soft-Drink Market. *Journal of Economics and Management Strategy*, *1*, 277-311.

Gayle, P. G. (2013). On the Efficiency of Codeshare Contracts between Airlines: Is Double Marginalization Eliminated. *American Economic Journal: Microeconomics*, *5*(4), 244-273.

Gayle, P. G., & Yimga, J. O. (2018). How Much Do Consumers Really Value Air Travel On-time Performance, and to What Extent Are Airlines Motivated to Improve Their On-time Performance? *Economics of Transportation*, *14*, 31-41

Glaser, L.K. & Thompson, G. D. "Demand For Organic And Conventional Beverage Milk," 2000 Annual Meeting, Vancouver, British Columbia, Western Agricultural Economics Association, June 29-July 1, 2000

Goldberg, P. K., & Verboven, F. (2001). The Evolution of Price Dispersion in the European Car Market. *The Review of Economic Studies, 68*(4), 811-848.

Gould, B. W. (1996). Factors Affecting U.S. Demand for Reduced-Fat Fluid Milk. *Journal of Agricultural and Resource Economics* , *21*(1), 68-81.

Grigolon, L., & Verboven, F. E. (2014). Nested logit or random coefficients logit? A comparison of alternative discrete choice models of product differentiation. *Review of Economics and Statistics*, *96*(5), 916-935.

Heien, D. M., & Wessells, C. R. (1988). "The Demand for Dairy Products: Structure, Prediction, and Decomposition". *American Journal of Agricultural Economics*, *70*(2), 219-229.

Huang, L., & Liu, Y. (2017). Health Information and Consumer Learning in the Bottled Water Market. *International Journal of Industrial Organization*, *55*, 1-24.

Information on Milk Prices, Factors Affecting Prices, and Dairy Policy Options. (2004, December). Retrieved from https://www.gao.gov/products/GAO-05-50

Ivaldi, M., & Verboven, F. (2005). Quantifying the effects from horizontal mergers in European competition policy. *International Journal of Industrial Organization*, *23*(9-10), 669-691.

Ippolito, P. M., & Mathios, A. D. (1990). Information, Advertising and Health Choices: A Study of the Cereal Market. *The RAND Journal of Economics*, *21*(3), 459-480.

Jesse, E., & Cropp, B. (2008). "*Basic Milk Pricing Concepts for Dairy Farmers"*. Madison, WI: University of Wisconsin- Extension, Cooperative Extension.

Jin, G. Z., & Leslie, P. (2003). The Effect of Information on Product Quality: Evidence from Restaurant Hygiene Grade Cards. *The Quarterly Journal of Economics*, *118*(2), 409-451.

Karaman, A. D., Özer, B., Pascall, M. A., & Alvarez, V. (2015). Recent Advances in Dairy Packaging. *Food Reviews International*, *31*, 295-318.

Kiesel, K., Buschena, D., & Smith, V. (2005). Do Voluntary Biotechnology Labels Matter to the Consumer? Evidence from the Fluid Milk Market. *American Journal of Agricultural Economics*, *87*(2), 378-392.

Kiesel, K., & Villas-Boas, S. B. (2007). Got Organic Milk? Consumer Valuations of Milk Labels after the Implementation of the USDA Organic Seal. *Journal of Agricultural & Food Industrial Organization*, *5*, 1-38.

Kiesel, K., & Villas-Boas, S. B. (2013). Got Organic Milk? Can information costs affect consumer choice? Nutritional labels in a supermarket experiment. *International Journal of Industrial Organization*, *31(2)*, 153-163.

Kinoshita, J., Suzuki, N., Kawamura, T., Watanabe, Y., & Kaiser, H. M. (2001). "Estimating Own and Cross Brand Price Elasticities, and Price–cost Margin Ratios Using Store-level Daily Scanner Data". *Agribusiness*, *17*(4), 515-525.

Kruger, Michael W. and Daniel Pagni, "IRI Academic Data Set Description, version *2.3*", Chicago: Information Resources Incorporated, 2008.

Kumbhakar, S. C., Baardsen, S., & Lien, G. (2012). "A New Method for Estimating Market Power with an Application to Norwegian Sawmilling". *Review of Industrial Organization*, *40*(2), 109-129.

Lopez, E. and Lopez, R. A. (2009). Demand for Differentiated Milk Products: Implications for Price Competition. *Agribusiness* 25(4): 453-465.

Mathios, A. D. (2000). The Impact of Mandatory Disclosure Laws on Product Choice: An Analysis of the Salad Dressing Market. *The Journal of Law & Economics*, *43*(2), 651-678.

McBride, W. D., & Greene, C. (2009). Characteristics, Costs and Issues for Organic Dairy Farming. *USDA Economic Research Report No.82*.

Meas, T., Hu, W., Batte, M. T., Woods, T. A., & Ernst, S. (2014). Substitutes or complements? Consumer preference for local and organic food attributes. *American Journal of Agricultural Economics*, *97(4)*, 1044-1071

Merel, P. R. (2009). "Measuring Market Power in the French Comté Cheese Market". *European Review of Agricultural Economics*, *36*(1), 31-51.

Morrison Paul, C. J. (2001). "Cost Economies and Market Power: The Case of the U.S. Meat Packing Industry". *The Review of Economics and Statistics*, *83*(3), 531-540.

Muth, M. K., Sweitzer, M., Brown, D., Capogrossi, K., Karns, S., Levin, D., Zhen, C. (2016, April). "Understanding IRI Household-Base and Store-Based Scanner Data". Retrieved from https://www.ers.usda.gov/webdocs/publications/tb1942/57105_tb-1942.pdf

Nelder, J. A., & Mead, R. (1965). A Simplex Method for Function Minimization. *The Computer Journal, 7*(4), 308-313.

Nevo, A. (2000). Mergers with Differentiated Products: The Case of the Ready-to-Eat Cereal Industry. *The RAND Journal of Economics*, *31*(3), 395-421.

Nevo, A. (2001). Measuring Market Power in the Ready-to-Eat Cereal Industry. *Econometrica*, *69*(2), 307-342.

Nevo, A. (2003). New Products, Quality Changes and Welfare Measures Computed from Estimated Demand Systems. *Review of Economics and Statistics*, *85*(2), 266-275.

Pepall, L., Richards, D., and Norman, G. (2014). Industrial Organization: Contemporary Theory and Empirical Applications. Chapter 6, Fifth Edition, *John Wiley and Sons Inc*.

Perekhozhuk, O., Hockmann, H., Ferto, I., & Bakucs, L. (2013). "Identification of Market Power in the Hungarian Dairy Industry: A Plant-Level Analysis". *Journal of Agricultural & Food Industrial Organization*, *11*(1), 1-13.

Peters, C. (2006). Evaluating the Performance of Merger Simulation: Evidence from the U.S. Airline Industry. *The Journal of Law & Economics*, *49*(2), 627-649.

Petrin, A. (2002). Quantifying the Benefits of New Products: The Case of the Minivan. *Journal of Political Economy*, *110*(4), 705-729.

Pinkse, J., & Slade, M. E. (2004). Mergers, brand competition, and the price of a pint. *European Economic Review*, *48*, 617-643.

Rey, P. and T. Verge (2008). Economics of Vertical Restraints. *Handbook of Antitrust Economics*. 353-390

Robinson, L., Segal, J., & Segal, R. (2018, March). Organic Foods: What You Need to Know. Retrieved from https://www.helpguide.org/articles/healthy-eating/organic-foods.htm

Schlenker, W., & Villas-Boas, S. B. (2009). Consumer and Market Responses to Mad Cow Disease. *American Journal of Agricultural Economics*, *91*(4), 1140-1152.

Schmalensee, R. (1988). Industrial Economics: An Overview. *The Economic Journal*, *98*(392), 643-681.

Schmit, T.M., Dong, D., Chung, C., Kaiser, H.M. & Gould, B.W. (2002) Identifying the Effects of Generic Advertising on the Household Demand for Fluid Milk and Cheese: A Two-Step Panel Data Approach. *Journal of Agricultural and Resource Economics* 27(1):165-186

Shapiro, C. (1996). Mergers with Differentiated Products. *Antitrust*, *10*(2), 23-30.

Shields, D. A. (2010, April 27). Consolidation and Concentration in the U.S. Dairy Industry. Retrieved from http://nationalaglawcenter.org/wpcontent/uploads/assets/crs/R41224.pdf

Shimshack, J. P., Ward, M. B., & Beatty, T. K. M. (2007). Mercury advisories: Information, education, and fish consumption. *Journal of Environmental Economics and Management*, *53*(2), 158-179.

Stukenberg, D., Blayney, D., & Miiiler, J. (2006). Major Advances in Milk Marketing: Government and Industry Consolidation. *Journal of Dairy Science*, *89*(4), 1195-1206.

Su, Y., & Cook, M. L. (2015). Price Stability and Economic Sustainability- Achievable Goals? A Case Study of Organic Valley. *American Journal of Agricultural Economics*, *97*(2), 635-651

Sudhir, K. (2001). Competitive Pricing Behavior in the Auto Market: A Structural Analysis. *Marketing Science*, *20*(1), 42-60.

Teisl, M. F., & Roe, B. (1998). The Economics of Labeling: An Overview of Issues for Health and Environmental Disclosure. *Agricultural and Resource Economics Review*, *27*(2), 140-150.

Teisl, M. F., Bockstael, N. E., & Levy, A. (2001). Measuring the Welfare Effects of Nutrition Information. *American Journal of Agricultural Economics*, *83*(1), 133-149.

Teisl, M. F., Roe, B., & Hicks, R. L. (2002). Can Eco-Labels Tune a Market? Evidence from Dolphin-Safe Labeling. *Journal of Environmental Economics and Management*, *43*(3), 339-359.

Thomadsen, R. (2005). The Effect of Ownership Structure on Prices in Geographically Differentiated Industries. *The RAND Journal of Economics*, *36*(4), 908-929.

U.S. Census Bureau: American Community Survey (ACS), Retrieved from https://www.census.gov/programs-surveys/acs/data/pums.html

U.S. Census Bureau: Business & Industry (1987-2002), Retrieved from https://www.census.gov/econ/concentration.html

U.S. Department of Agriculture, Agricultural Marketing Service: Class I Differentials, Retrieved from https://www.ams.usda.gov/sites/default/files/media/DYFMMOCA%20Table%203%20Class%20I%20Differentials.pdf

U.S. Department of Energy (DOE) (2006b). Manufacturing Consumption of Energy 2006 Data Tables. Energy Information Administration, Washington, D.C. http://www.eia.doe.gov/emeu/mecs/

U.S. and Plaintiff States v. Dean Foods Co., Case No. 10-CV-59. Antitrust Division of Department of Justice of The United States. 2010-2011

Villas-Boas, S. B. (2007). Vertical relationships between manufacturers and retailers: inference with limited data. *The Review of Economic Studies, 74*(2), 625-652.

Vaclavik, V. A., & Christian, E. W. (2007). Milk and Milk Products. In *Essentials of Food Sciences* (pp. 201-203). Springer.

Vuong, Q. (1989). Likelihood Ratio Tests for Model Selection and Non-Nested Hypotheses. *Econometrica*, *57*(2), 307-333.

Willig, R. D. (1991). Merger Analysis, Industrial Organization Theory, and the Merger Guidelines. *Brookings Papers on Economic Activity, Microeconomics*, 281-332.

Xia, T., & Sexton, Richard J. (2009). Retail Prices for Milk by Fat Content: A New Theory and Empirical Test of Retailer Pricing Behavior. *Journal of Agricultural and Resource Economics*, *34*(2), 256–275.

Yadav, D. N., Sangita, B., Arvind, K. J., & Ranjeet, S. (2017). Plant Based Dairy Analogues: An Emerging Food. *Agricultural Research & Technology: Open Access Journal*, 1-4.

Appendix A

This Appendix contains six tables (Table A.1-A.9). Table A1 presents the standard logit demand estimation results using Ordinary Least Square (OLS). Table A2 reports the standard logit demand estimation results using two-stage least squares (2SLS). Table A.3-A.9 present the own- and cross-price elasticities of different brands in four package sizes in two selected markets.

Table A.1: Standard Logit Demand Estimation for Four Package Sizes of Milk (OLS)

	Ordinary Least Square Estimation (OLS)							
	Variables and Parameters in the mean utility function [parameters: $(\beta, \alpha, \rho_{year}, \tau_{month}, \gamma_{market})$].							
	Size 1 (16 ounces Container)		Size 2 (32 ounces Container)		Size 3 (0.5 gallon Container)		Size 4 (1 gallon Container)	
	Coefficient Estimates	Std. Error	Coefficient Estimates	Std. Error	Coefficient Estimates	Std. Error	Coefficient Estimates	Std. Error
Real Milk Price	-47.81**	0.59	-21.00**	0.54	-32.59**	0.27	-39.12**	0.75
Fat Content [a]	-0.79**	0.012	-1.03**	0.01	-1.23**	0.004	-1.47**	0.01
Flavor: Vanilla [a]	-1.55**	0.03	0.10**	0.02	-1.47**	0.01	-0.06*	0.03
Flavor: Original [a]	-	-	-	-	-1.64**	0.01	-	-
Flavor: Plain [a]	-	-	-	-	-1.38**	0.01	-	-
Milk type: Full lactose [a]	-	-	2.30**	0.03	-	-	-	-
Milk type [1]: Reduced lactose [a]	-	-	-	-	-1.09**	0.01	-	-
Milk type[2]: Milk with acidophilus [a]	-	-	-	-	-4.02**	0.02	-	-
Milk type: Soy milk [a]	-	-	-	-	-0.75**	0.01	-	-
Milk type: Almond milk [a]	-	-	-	-	-1.78**	0.02	-	-
Organic [a]	-	-	-	-	-0.72**	0.01	-1.14**	0.02
Constant [a]	-0.58**	0.19	0.83**	0.27	2.99**	0.10	-11.22**	0.10
Time fixed effects	YES		YES		YES		YES	
Product fixed effects	YES		YES		YES		YES	
Market fixed effects	YES		YES		YES		YES	
R^2	0.9967		0.9984		0.9980		0.9961	
Observations	21,114		29,901		158,439		45,267	

Notes: *indicates statistical significance at the 10% level, **indicates statistical significance at the 5% level
[1] Reduced lactose also includes lactose free milk.
[2] The milk is full lactose with acidophilus
[a] Coefficient estimates from the Generalized Least Square regression of estimated product fixed effects on non-price product characteristics.

Table A.2: Standard Logit Demand Estimation for Four Package Sizes of Milk (2SLS)

	Two-Stage Least Squares Estimation (2SLS)							
	Variables and Parameters in the mean utility function [parameters: $(\beta, \alpha, \rho_{year}, \tau_{month}, \gamma_{market})$].							
	Size 1 (16 ounces Container)		Size 2 (32 ounces Container)		Size 3 (0.5 gallon Container)		Size 4 (1 gallon Container)	
	Coefficient Estimates	Std. Error	Coefficient Estimates	Std. Error	Coefficient Estimates	Std. Error	Coefficient Estimates	Std. Error
Real Milk Price	-169.37**	2.41	-87.35**	2.41	-69.95**	1.38	-232.16**	8.46
Fat Content [a]	-0.79**	0.02	-1.03**	0.01	-1.23**	0.004	-1.42**	0.01
Flavor: Vanilla [a]	-1.68**	0.05	0.10**	0.02	-1.43**	0.01	-0.13**	0.05
Flavor: Original [a]	-	-	-	-	-1.59**	0.01	-	-
Flavor: Plain [a]	-	-	-	-	-1.39**	0.01	-	-
Milk type: Full lactose [a]	-	-	2.26**	0.05	-	-	-	-
Milk type [1]: Reduced lactose [a]	-	-	-	-	-0.92**	0.01	-	-
Milk type[2]: Milk with acidophilus [a]	-	-	-	-	-3.82**	0.02	-	-
Milk type: Soy milk [a]	-	-	-	-	-0.85**	0.02	-	-
Milk type: Almond milk [a]	-	-	-	-	-1.80**	0.02	-	-
Organic [a]	-	-	-	-	-0.60**	0.01	0.24**	0.05
Constant [a]	-031	0.32	0.82**	0.34	2.95**	0.11	-10.14**	0.16
Time fixed effects	YES		YES		YES		YES	
Product fixed effects	YES		YES		YES		YES	
Market fixed effects	YES		YES		YES		YES	
Observations	21,114		29,901		158,439		45,267	
Test of Endogeneity: H_0: Real Milk Price is Exogenous Dubin (score) Chi-sq (1)	9605.71 (P-Value = 0.00)		1242.33 (P-Value = 0.00)		867.63 (P-Value = 0.00)		1324.44 (P-Value = 0.00)	
Wu-Hausman F(1, 20480)	17094.2 (P-Value = 0.00)		1248.59 (P-Value = 0.00)		841.21 (P-Value = 0.00)		1322.17 (P-Value = 0.00)	

Notes: *indicates statistical significance at the 10% level, **indicates statistical significance at the 5% level

[1] Reduced lactose also includes lactose free milk.

[2] The milk is full lactose with acidophilus

[a] Coefficient estimates from the Generalized Least Square regression of estimated product fixed effects on non-price product characteristics.

Table A.3: The Own- and Cross-Price Elasticities of Different Brands in 16 Ounces Containers

Market: Green Bay in March 2007				**Market: Milwaukee in March 2007**			
Brands	Deans	Golden Grnsy Mg	Kemps	Brands	Deans	Golden Grnsy Mg	Kemps
Deans	-11.6194**	0.00028**	0.00016**	Deans	-10.9011**	0.00103**	0.00080**
	(0.1538)	(5.51E-05)	(3.00E-05)		(0.2031)	(0.0001)	(7.82E-05)
Golden Grnsy Mg	0.00021**	-12.7289**	0.00017**	Golden Grnsy Mg	0.00091**	-11.3917**	0.00102**
	(4.83E-05)	(0.5670)	(3.00E-05)		(0.0001)	(0.2751)	(0.0001)
Kemps	0.00033**	0.00023**	-13.9675**	Kemps	0.00099**	0.00069**	-10.7734**
	(9.37E-05)	(8.62E-05)	(1.2329)		(8.15E-05)	(5.57E-05)	(0.2569)

Noted: **indicates statistical significance at the 5% level, standard error is reported in parenthesis. Deans is owned by Dean Foods and Golden Grnsy Mg is owned by Foremost Farms

Table.A.4: The Own- and Cross-Price Elasticities of Different Brands in 32 Ounces Containers

Market: Green Bay in March 2007								
Brands	Deans	Deans Easy	Golden Guernsey	Golden Grnsy Mg	Morning Glory	Hood Lactaid	Kemps	Private Label
Deans	-7.9296**	0.00021**	0.00073**	0.00087**	0.00050**	0.00068**	0.00060**	0.00152**
	(0.0771)	(3.06E-05)	(2.74E-05)	(7.50E-05)	(7.12E-05)	(6.45E-05)	(4.00E-05)	(0.0002)
Deans Easy	0.00076**	-9.5570**	0.00104**	0.00127**	0.00068**	0.00107**	0.00083**	0.00225**
	(0.00017)	(0.4191)	(0.0001)	(0.0002)	(2.19E-04)	(0.0002)	(0.0001)	(0.0005)
Golden Guernsey	0.00049**	0.00019**	-7.7561**	0.00082**	0.00048**	0.00063**	0.00057**	0.00144**
	(8.87E-05)	(5.39E-05)	(0.3358)	(0.0001)	(1.22E-04)	(0.0001)	(7.01E-05)	(0.0003)
Golden Grnsy Mg	0.00048**	0.00019**	0.00067**	-7.4949**	0.00046**	0.00063**	0.00056**	0.00141**
	(6.13E-05)	(3.62E-05)	(3.57E-05)	(0.2206)	(8.32E-05)	(7.56E-05)	(4.91E-05)	(0.0002)
Morning Glory	0.00033**	0.00012**	0.00047**	0.00056**	-5.9877**	0.00040**	0.00041**	0.00097**
	(5.21E-05)	(2.92E-05)	(3.27E-05)	(7.56E-05)	(0.3531)	(6.01E-05)	(4.59E-05)	(0.00065)
Hood Lactaid	0.00085**	0.00037**	0.00117**	0.00142**	0.00075**	-10.1274**	0.00092**	0.00253**
	(0.0001)	(7.54E-05)	(6.25E-05)	(0.0002)	(1.46E-04)	(0.0520)	(8.31E-05)	(0.0003)
Kemp	0.00037**	0.00014**	0.00052**	0.00062**	0.00037**	0.00045**	-6.4341**	0.00107**
	(6.61E-05)	(3.78E-05)	(3.63E-05)	(9.51E-05)	(9.67E-05)	(7.68E-05)	(0.2501)	(0.0002)
Private Label	0.00050**	0.00020**	0.00070**	0.00084**	0.00048**	0.00065**	0.00058**	-7.6429**
	(7.02E-05)	(4.25E-05)	(4.30E-05)	(0.0001)	(9.47E-05)	(8.81E-05)	(5.66E-05)	(0.3106)

Noted: **indicates statistical significance at the 5% level, standard error is reported in parenthesis. The brands of Dean Easy and Hood Lactaid are reduced lactose dairy milk, Deans and Deans Easy are owned by Dean Foods; Golden Guernsey, Golden Grnsy Mg and Morning Glory are owned by Foremost Farms.

Table A.5: The Own- and Cross-Price Elasticities of Different Brands in 32 Ounces Containers

Market: Milwaukee in March 2007						
Brands	Deans	Deans Easy	Golden Guernsey	Kemps	Hood Lactaid	Private Label
Deans	-8.5463**	0.00003**	0.00057**	0.00017**	0.00011**	0.00077**
	(0.1984)	(1.94E-06)	(5.24E-05)	(1.05E-05)	(4.76E-06)	(4.46E-05)
Deans Easy	0.00025**	-10.5024**	0.00072**	0.00021**	0.00015**	0.00102**
	(3.09E-05)	(0.1791)	(0.0002)	(2.81E-05)	(1.36E-05)	(0.0001)
Golden Guernsey	0.00018**	0.00003**	-7.7286**	0.00016**	0.00010**	0.00068**
	(1.51E-05)	(2.47E-06)	(0.0952)	(1.47E-05)	(6.22E-06)	(5.49E-05)
Kemps	0.00016**	0.00003**	0.00047**	-7.0822**	0.00009**	0.00060**
	(8.18E-06)	(1.29E-06)	(3.97E-05)	(0.0377)	(3.33E-06)	(2.76E-05)
Hood Lactaid	0.00026**	0.00005**	0.00073**	0.00021**	-10.576**	0.00103**
	(1.61E-05)	(2.84E-06)	(7.50E-05)	(1.47E-05)	(0.0416)	(6.78E-05)
Private Label	0.00022**	0.00004**	0.00064**	0.00019**	0.00013**	-9.4783**
	(3.46E-05)	(6.92E-06)	(0.00052)	(3.18E-05)	(1.55E-05)	(1.12)

Noted: **indicates statistical significance at the 5% level, standard error is reported in parenthesis. The brands of Dean Easy and Hood Lactaid are reduced lactose dairy milk, Deans and Deans Easy are owned by Dean Foods; Golden Guernsey, Golden Grnsy Mg and Morning Glory are owned by Foremost Farms USA.

Table A.6: The Own- and Cross-Price Elasticities of Different Brands in 0.5 Gallon Containers

Market: Green Bay in March 2007												
Brands	8th Continent	Kemps	Kemps Select	Morning Glory	Golden Guernsey	Organic Valley	Silk Light	Deans Easy	Deans	Land O' Lakes Dairy Ease	Private Label	Hood Lactaid
8th Continent	-5.7952**	0.00088**	0.00005**	0.00078**	0.00063**	0.00013**	0.00004**	0.00015**	0.00023**	0.00005**	0.00037**	0.00017**
	(0.0701)	(8.40 E-05)	(9.84 E-08)	(8.05 E-05)	(9.94 E-05)	(1.24 E-05)	(2.14 E-06)	(1.25 E-05)	(2.05 E-05)	(2.87 E-07)	(2.38 E-05)	(1.34 E-05)
Kemps	0.00004**	-2.7632**	0.00005**	0.00076**	0.00060**	0.00011**	0.00003**	0.00014**	0.00023**	0.00005**	0.00037**	0.00014**
	(5.49 E-06)	(0.2351)	(1.10 E-07)	(0.0001)	(0.0002)	(1.89 E-05)	(3.48 E-06)	(2.08 E-05)	(3.63 E-05)	(8.25 E-07)	(4.03 E-05)	(2.07 E-05)
Kemps Select	0.00004**	0.00085**	-3.0582**	0.00076**	0.00060**	0.00011**	0.00003**	0.00014**	0.00022**	0.00005**	0.00036**	0.00014**
	(7.82 E-06)	(0.0002)	(0.2562)	(0.0002)	(0.0003)	(2.75 E-05)	(4.99 E-06)	(3.04 E-05)	(5.50 E-07)	(5.50 E-07)	(6.00 E-05)	(3.01 E-05)
Morning Glory	0.00004**	0.00086**	0.00005**	-2.7261**	0.00060**	0.00011**	0.00003**	0.00013**	0.00023**	0.00005**	0.00036**	0.00014**
	(4.42 E-06)	(0.0002)	(4.22 E-08)	(0.0871)	(0.0001)	(1.53 E-05)	(4.95 E-06)	(1.66 E-05)	(5.29 E-07)	(4.40 E-07)	(3.36 E-05)	(1.67 E-05)
Golden Guernsey	0.00004**	0.00085**	0.00005**	0.00076**	-2.8057**	0.00010**	0.00003**	0.00013**	0.00022**	0.00005**	0.00036**	0.00014**
	(7.75 E-06)	(0.0002)	(8.47 E-08)	(0.0002)	(0.2382)	(2.72 E-05)	(4.94 E-06)	(3.01 E-05)	(4.86 E-07)	(4.86 E-07)	(5.99 E-05)	(2.97 E-05)
Organic Valley	0.00006**	0.00093**	0.00005**	0.00080**	0.00064**	-6.7703**	0.00004**	0.00016**	0.00024**	0.00006**	0.00039**	0.00019**
	(5.18 E-06)	(0.0001)	(2.36 E-07)	(0.0001)	(0.0001)	(0.1325)	(3.19 E-06)	(1.84 E-05)	(1.09 E-06)	(1.09 E-07)	(3.21 E-05)	(2.05 E-05)
Silk Light	0.00005**	0.00088**	0.00005**	0.00078**	0.00062**	0.00012**	-5.3448**	0.00015**	0.00023**	0.00005**	0.00037**	0.00016**
	(4.04 E-06)	(0.0001)	(1.40 E-07)	(9.65 E-05)	(0.0001)	(1.45 E-05)	(0.1602)	(1.48 E-05)	(2.45 E-05)	(6.31 E-07)	(2.85 E-05)	(1.57 E-05)
Deans Easy	0.00005**	0.00087**	0.00005**	0.00078**	0.00062**	0.00012**	0.00004**	-5.2679**	0.00005**	0.00037**	0.00016**	0.00005**
	(6.06 E-06)	(0.0002)	(1.44 E-07)	(0.0001)	(0.0002)	(2.18 E-05)	(3.79 E-06)	(0.1187)	(4.14 E-07)	(4.24 E-07)	(4.29 E-05)	(2.36 E-05)
Deans	0.00004**	0.00088**	0.00005**	0.00076**	0.00060**	0.00011**	0.00003**	0.00014**	-2.8921**	0.00005**	0.00037**	0.00014**
	(4.91 E-06)	(0.0001)	(7.05 E-08)	(0.0001)	(0.0002)	(1.70 E-05)	(3.11 E-06)	(1.85 E-05)	(0.1290)	(6.43 E-07)	(3.63 E-05)	(1.86 E-05)
Land O' Lakes Dairy Ease	0.00005**	0.00089**	0.00005**	0.00079**	0.00063**	0.00013**	0.00004**	0.00016**	0.00023**	-6.2278**	0.00037**	0.00017**
	(1.32 E-05)	(0.0003)	(5.05 E-07)	(0.0003)	(0.0005)	(4.98 E-05)	(8.35 E-06)	(5.25 E-05)	(6.43 E-07)	(0.0000)	(8.99 E-05)	(5.37 E-05)
Private Label	0.00004**	0.00088**	0.00005**	0.00076**	0.00060**	0.00011**	0.00003**	0.00014**	0.00023**	0.00005**	-2.7616**	0.00014**
	(3.15 E-06)	(8.01 E-05)	(4.28 E-08)	(8.09 E-05)	(9.89 E-05)	(1.08 E-05)	(1.99 E-06)	(1.17 E-05)	(2.06 E-05)	(3.75 E-07)	(0.0808)	(1.18 E-05)
Hood Lactaid	0.00005**	0.00091**	0.00005**	0.00079**	0.00064**	0.00014**	0.00004**	0.00016**	0.00024**	0.00006**	0.00038**	-6.3098**
	(4.96 E-06)	(0.0001)	(1.79 E-07)	(0.0001)	(0.0001)	(1.81 E-05)	(3.07 E-06)	(1.78 E-05)	(2.85 E-05)	(9.42 E-07)	(3.22 E-05)	(0.0492)

Note: **indicates statistical significance at the 5% level, standard error is reported in parenthesis. The brands of Dean Easy, Land O'Lakes Dairy Ease and Hood Lactaid are reduced lactose dairy milk, the brand Organic Valley is the organic milk, Deans and Deans Easy, Land O'Lakes Dairy Ease are owned by Dean Foods; Golden Guernsey and Morning Glory are owned by Foremost Farms.

Table A.7: The Own- and Cross-Price Elasticities of Different Brands in 0.5 Gallon Containers

Market: Milwaukee in March 2007															
Brands	Organic Valley	Silk Light	Oberweis Dairy	Deans	Deans Easy	Land O' Lakes Dairy Ease	Horizon Organic	Kemps	Kemps Select	Kemps New Era	8th Continent	Private Label	Hood Lactaid	Golden Guernsey	Wisconsin Organics
Organic Valley	-5.1607**	9.22E-05**	1.85E-04**	2.72E-04**	0.00047**	9.14 E-05**	5.71 E-05**	0.00048**	4.11 E-05**	4.31 E-06**	1.22 E-04**	0.00043**	0.00073**	7.98 E-04**	0.00019**
	(0.0491)	(2.33 E-06)	(9.08 E-06)	(1.67 E-05)	(1.67 E-05)	(1.13 E-05)	(2.81 E-06)	(1.87 E-05)	(1.54 E-06)	(1.09 E-07)	(3.33 E-06)	(1.53 E-05)	(2.72 E-05)	(3.84 E-05)	(6.62 E-06)
Silk Light	2.32E-04**	-5.0153**	8.25E-05**	2.14E-04**	0.00021**	3.65 E-05**	2.12 E-05**	0.00035**	2.69 E-05**	2.95 E-06**	5.38 E-05**	0.00030**	0.00029**	5.17 E-04**	7.51 E-05**
	(7.47 E-06)	(0.0350)	(4.49 E-06)	(1.56 E-05)	(7.43 E-06)	(4.83 E-06)	(1.03 E-06)	(1.79 E-05)	(1.03 E-06)	(3.21 E-08)	(1.56 E-06)	(1.24 E-05)	(1.17 E-05)	(1,27 E-05)	(1.86 E-06)
Oberweis Dairy	2.44E-04**	4.21E-05**	-4.7578**	2.20E-04**	0.00022**	3.79 E-05**	2.25 E-05**	0.00036**	2.72 E-05**	2.98 E-06**	5.55 E-05**	0.00031**	0.00030**	5.23 E-04**	7.96 E-05**
	(4.26 E-06)	(1.65 E-06)	(0.0352)	(2.43 E-05)	(1.19 E-05)	(7.87 E-06)	(1.76 E-06)	(2.75 E-05)	(1.62 E-06)	(5.06 E-08)	(2.46 E-06)	(1.91 E-05)	(1.88 E-05)	(4.50 E-05)	(3.37 E-06)
Deans	8.70E-05**	2.19E-05**	4.64E-05**	-3.1191**	0.00012**	1.66 E-05**	8.68 E-06**	0.00030**	2.14 E-05**	2.41 E-06**	2.88 E-05**	0.00026**	0.00013**	4.08 E-04**	3.46 E-05**
	(1.52 E-05)	(7.59 E-07)	(3.67 E-06)	(0.1843)	(6.04 E-06)	(3.20 E-06)	(6.54 E-07)	(2.37 E-05)	(1.13 E-06)	(1.07 E-07)	(1.20 E-06)	(1.48 E-05)	(7.79 E-05)	(2.76 E-05)	(1.75 E-06)
Deans Easy	2.20E-04**	3.93E-05**	7.95E-05**	2.12E-04**	-4.9741**	3.49 E-05**	2.02 E-05**	0.00034**	2.64 E-05**	2.91 E-06**	5.18 E-05**	0.00030**	0.00028**	5.08 E-04**	7.17 E-05**
	(1.52 E-05)	(2.13 E-06)	(9.46 E-06)	(3.43 E-05	(0.0696)	(1.03 E-05)	(2.06 E-06)	(3.94 E-05)	(2.22 E-06)	(4.55 E-08)	(3.25 E-06)	(2.69 E-05)	(2.42 E-05)	(5.55 E-05)	(2.53 E-06)
Land O' Lakes Dairy Ease	0.00033**	5.40E-05**	1.09E-04**	2.29E-04**	0.00028**	-5.3734**	3.03 E-05**	0.00038**	3.06 E-05**	3.30 E-06**	7.12 E-05**	0.00034**	0.00040**	5.90 E-04**	0.00010**
	(3.59 E-05)	(4.69 E-06)	(2.02 E-05)	(5.80 E-05)	(3.13 E-05)	(4.44 E-05)	(4.99 E-06)	(6.57 E-05)	(4.21 E-06)	(0.00000)	(7.01 E-06)	(4.74 E-05)	(5.48 E-05)	(1.06 E-04)	(5.53 E-08)
Horizon Organic	0.00047**	7.09E-05**	1.43E-04**	2.51E-04**	0.00036**	6.85 E-05**	-5.2232**	0.00043**	3.52 E-05**	3.75 E-06**	9.35 E-05**	0.00038**	0.00055**	6.82 E-04**	0.00014**
	(3.63 E-05)	(4.54 E-06)	(1.86 E-05)	(4.29 E-05)	(3.13 E-05)	(2.33 E-05)	(0.1377)	(4.78 E-05)	(3.45 E-06)	(1.37 E-07)	(6.62 E-06)	(3.68 E-05)	(5.32 E-05)	(8.72 E-05)	(8.39 E-06)
Kemps	9.98E-05**	2.38E-05**	5.06E-05**	1.99E-04**	0.00013**	1.86 E-05**	1.01 E-05**	-3.3062**	2.19 E-05**	2.47 E-06**	3.13 E-05**	0.00026**	0.00015**	4.19 E-04**	3.93 E-05**
	(4.83 E-06)	(8.23 E-07)	(5.28 E-06)	(1.97 E-05)	(6.57 E-06)	(3.54 E-06)	(8.17 E-07)	(0.1590)	(1.12 E-06)	(3.96 E-08)	(1.28 E-06)	(1.44 E-05)	(8.60 E-06)	(2.75 E-05)	(2.44 E-06)
Kemps Select	9.14E-05**	2.26E-05**	4.67E-05**	1.93E-04**	0.00012**	1.73 E-05**	8.88 E-06**	0.00030**	-3.5898**	2.44 E-06**	2.98 E-05**	0.00026**	0.00014**	4.13 E-04**	3.50 E-05**
	(5.91E-06)	(1.07 E-06)	(5.19 E-06)	(2.92 E-05)	(8.26 E-06)	(4.63 E-06)	(7.83 E-07)	(3.41 E-05)	(0.1175)	(1.90 E-08)	(1.71 E-06)	(2.14 E-05)	(1.11 E-05)	(3.97 E-05)	(1.38 E-06)
Kemps New Era	8.49E-05**	2.18E-05**	4.50E-05**	1.92E-04**	0.00012**	1.64 E-05**	8.29 E-06**	0.00030**	2.14 E-05**	-3.4606**	2.87 E-05**	0.00025**	0.00013**	4.08 E-04**	3.31 E-05**
	(1.35 E-05)	(2.53 E-06)	(1.30 E-05)	(7.38 E-05)	(2.12 E-05)	(1.44 E-05)	(1.94 E-06)	(8.61 E-05)	(4.24 E-06)	(0.00000)	(4.07 E-06)	(5.30 E-05)	(2.61 E-05)	(1.10 E-04)	(3.41 E-06)
8th Continent	2.37E-04**	4.14E-05**	8.38E-05**	2.15E-04**	0.00022**	3.72 E-05**	2.17 E-05**	0.00035**	2.71E-05**	2.96 E-06**	-5.0641**	0.00030**	0.00030**	5.20 E-04**	7.64 E-05**
	(7.21 E-06)	(9.98 E-07)	(4.39 E-06)	(1.54 E-05)	(6.95 E-06)	(4.70 E-06)	(9.55 E-07)	(1.76 E-05)	(1.00 E-06)	(1.42 E-08)	(0.0156)	(1.22 E-05)	(1.14 E-05)	(2.52 E-05)	(8.45 E-07)
Private Label	9.49E-05**	2.29E-05**	4.87E-05**	1.98E-04**	0.00012**	1.76 E-05**	9.44 E-06**	0.00031**	2.16 E-05**	2.44 E-06**	3.01 E-05**	-3.1974**	0.00014**	4.14 E-04**	3.72 E-05**
	(3.42 E-06)	(5.90 E-07)	(2.83 E-06)	(1.51 E-05)	(4.66 E-06)	(2.50 E-06)	(5.56 E-07)	(1.74 E-05)	(8.47 E-07)	(2.40 E-08)	(9.30 E-07)	(0.0948)	(6.11 E-06)	(2.07 E-05)	(1.58 E-06)
Hood Lactaid	0.00037**	5.89E-05**	1.19E-04**	2.37 E-04**	0.00030**	5.57 E-05**	3.40 E-05**	0.00040**	3.19 E-05**	3.43 E-06**	6.26 E-05**	0.00035**	-5.2039**	6.16 E-04**	0.00012**
	(1.34 E-05)	(1.72 E-06)	(7.13 E-06)	(1.87 E-05)	(1.19 E-05)	(8.29 E-06)	(1.89 E-06)	(2.11 E-05)	(1.40 E-06)	(5.16 E-08)	(1.92 E-06)	(1.56 E-05)	(0.0474)	(3.54 E-05)	(3.32 E-06)
Golden Guernsey	8.16E-05**	2.13E-05**	4.41E-05**	1.91 E-04**	0.00011**	1.60 E-05**	8.00 E-06**	0.00030**	2.12 E-05**	2.40 E-06**	2.81E-05**	0.00025**	0.00013**	-3.2638**	3.21 E-05**
	(4.50 E-06)	(8.32 E-07)	(4.12 E-06)	(2.36 E-05)	(6.57 E-06)	(3.50 E-06)	(6.23 E-07)	(2.76 E-05)	(1.30 E-06)	(2.64 E-08)	(1.33 E-06)	(1.72 E-05)	(8.51 E-06)	(0.1975)	(1.54 E-06)
Wisconsin Organics	0.00036**	5.74E-05**	1.17E-04**	2.37 E-04**	0.00030**	5.42 E-05**	3.31 E-05**	0.00040**	3.15 E-05**	3.39 E-06**	7.57 E-05**	0.00035**	0.00043**	6.08 E-04**	-5.1078**
	(4.04 E-05)	(5.23 E-06)	(2.20 E-05)	(5.85 E-05)	(3.78 E-05)	(2.84 E-05)	(6.11 E-06)	(6.55 E-05)	(4.42 E-06)	(2.25 E-07)	(7.70 E-06)	(4.81 E-05)	(6.07 E-05)	(1.10 E-04)	(0.1700)

Note: **indicates statistical significance at the 5% level, standard error is reported in parenthesis. The brands of Dean Easy, Land O'Lakes Dairy Ease and Hood Lactaid are reduced lactose dairy milk, the brand Organic Valley, Horizon Organic and Wisconsin Organics are the organic milk, Deans and Deans Easy, Land O'Lakes Dairy Ease and Horizon Organic are owned by Dean Foods; Golden Guernsey is owned by Foremost Farms.

Table A.8: The Own- and Cross-Price Elasticities of Different Brands in 1 Gallon Containers

Market: Green Bay in March 2007								
Brands	Deans	Golden Guernsey	Morning Glory	Kemps	Private Label	Organic Valley	Wisconsin Organics	Dairy lands best
Deans	-6.39345**	0.01428**	0.02704**	0.03820**	0.03294**	0.00166**	0.00099**	0.01859**
	(0.29030)	(0.00863)	(0.02006)	(0.03157)	(0.03161)	(0.00082)	(0.00095)	(0.00043)
Golden Guernsey	0.00765**	-6.82660**	0.02933**	0.04170**	0.03529**	0.00194**	0.00112**	0.01939**
	(0.00374)	(0.27146)	(0.02116)	(0.03433)	(0.03298)	(0.00093)	(0.00120)	(0.00015)
Morning Glory	0.00718**	0.01461**	-6.48814**	0.03910**	0.03352**	0.00175**	0.00103**	0.01876**
	(0.00358)	(0.00855)	(0.59748)	(0.03176)	(0.03184)	(0.00088)	(0.00102)	(0.00098)
Kemps	0.00746**	0.01514**	0.02859**	-6.58687**	0.03442**	0.00184**	0.00105**	0.01891**
	(0.00362)	(0.00863)	(0.02045)	(0.84004)	(0.03198)	(0.00094)	(0.00108)	(0.00139)
Private Label	0.00712**	0.01436**	0.02728**	0.03895**	-6.16470**	0.00161**	0.00088**	0.01813**
	(0.00339)	(0.00773)	(0.01928)	(0.03077)	(0.51360)	(0.00078)	(0.00080)	(0.00088)
Organic Valley	0.01004**	0.02238**	0.03903**	0.05318**	0.04543**	-11.8522**	0.00670**	0.02465**
	(0.00508)	(0.01464)	(0.02797)	(0.04016)	(0.04652)	(0.87930)	(0.00788)	(0.00049)
Wisconsin Organics	0.01004**	0.02251**	0.03911**	0.05313**	0.04548**	0.00860**	-12.0372**	0.02473**
	(0.00526)	(0.01610)	(0.02868)	(0.04149)	(0.04740)	(0.00661)	(1.18720)	(0.00054)
Dairy lands best	0.00538**	0.01120**	0.02132**	0.02884**	0.02738**	0.00116**	0.00090**	-5.74993**
	(0.00365)	(0.01216)	(0.02001)	(0.03065)	(0.03166)	(0.00071)	(0.00120)	(0.00000)

Noted: **indicates statistical significance at the 5% level, standard error is reported in parenthesis. The brands of Organic Valley and Wisconsin Organics are organic dairy milk, Deans is owned by Dean Foods; Golden Guernsey and Morning Glory are owned by Foremost Farms.

Table A.9: The Own- and Cross-Price Elasticities of Different Brands in 1 Gallon Containers

Market: Milwaukee in March 2007							
Brands	Deans	Golden Guernsey	Kemps	Private Label	Organic Valley	Wisconsin Organics	Borden Milk
Deans	-6.7046**	0.0126**	0.0131**	0.0250**	0.0035**	0.0020**	0.0216**
	(0.1643)	(0.0009)	(0.0010)	(0.0017)	(0.0003)	(0.0002)	(0.0006)
Golden Guernsey	0.0187**	-7.8493**	0.0181**	0.0322**	0.0059**	0.0033**	0.0255**
	(0.0018)	(0.0660)	(0.0011)	(0.0018)	(0.0003)	(0.0003)	(0.0002)
Kemps	0.0172**	0.0161**	-7.2944**	0.0296**	0.0052**	0.0028**	0.0236**
	(0.0014)	(0.0008)	(0.1798)	(0.0014)	(0.0003)	(0.0002)	(0.0006)
Private Label	0.0144**	0.0130**	0.0137**	-6.3919**	0.0039**	0.0021**	0.0205**
	(0.0009)	(0.0005)	(0.0006)	(0.0926)	(0.0002)	(0.0001)	(0.0004)
Organic Valley	0.0258) **	0.0271**	0.0254**	0.0435**	-12.0652**	0.0057**	0.0344**
	(0.0021)	(0.0012)	(0.0013)	(0.0021)	(0.1426)	(0.0004)	(0.0012)
Wisconsin Organics	0.0255**	0.0266**	0.0251**	0.0430**	0.0100**	-11.7027**	0.0339**
	(0.0034)	(0.0020)	(0.0020)	(0.0034)	(0.0007)	(0.1510)	(0.0020)
Borden Milk	0.0101**	0.0096**	0.0097**	0.0210**	0.0020**	0.0012**	-6.6134**
	(0.0032)	(0.0026)	(0.0029)	(0.0052)	(0.0004)	(0.0005)	(0.0000)

Noted: **indicates statistical significance at the 5% level, standard error is reported in parenthesis. The brands of Organic Valley and Wisconsin Organics are organic dairy milk, Deans is owned by Dean Foods; Golden Guernsey is owned by Foremost Farms.

Appendix B

Table B1: The Coefficient Estimates of the Interactions of Organic Dummy with Time Periods Dummy Variables from Jan 2006 to Dec 2012

Variables	Coefficient	Standard Error
Organic dummy *Jan_2006	3.2431**	0.6295
Organic dummy *Feb_2006	3.2360**	0.5178
Organic dummy *Mar_2006	3.4204**	0.6304
Organic dummy *Apr_2006	3.3702**	0.6258
Organic dummy *May_2006	3.2925**	0.5463
Organic dummy *Jun_2006	3.1909**	0.6111
Organic dummy *Jul_2006	3.4782**	0.6021
Organic dummy *Aug_2006	3.4908**	0.5919
Organic dummy *Sep_2006	3.3830**	0.6031
Organic dummy *Oct_2006	2.7897**	0.4604
Organic dummy *Nov_2006	3.1008**	0.5545
Organic dummy *Dec_2006	3.2483**	0.5533
Organic dummy *Jan_2007	2.5250**	0.5446
Organic dummy *Feb_2007	2.2508**	0.5269
Organic dummy *Mar_2007	2.3894**	0.5040
Organic dummy *Apr_2007	2.6048**	0.6568
Organic dummy *May_2007	2.4256**	0.4633
Organic dummy *Jun_2007	2.5812**	0.5179
Organic dummy *Jul_2007	2.0173**	0.5462
Organic dummy *Aug_2007	2.4794**	0.5304
Organic dummy *Sep_2007	2.0256**	0.5945
Organic dummy *Oct_2007	1.7563**	0.4703
Organic dummy *Nov_2007	1.8608**	0.5005
Organic dummy *Dec_2007	2.2975**	0.4982
Organic dummy *Jan_2008	1.8182**	0.5199
Organic dummy *Feb_2008	2.3686**	0.4253
Organic dummy *Mar_2008	2.1724**	0.4377
Organic dummy *Apr_2008	2.3264**	0.4985
Organic dummy *May_2008	2.1459**	0.4753
Organic dummy *Jun_2008	2.2953**	0.4851
Organic dummy *Jul_2008	2.0224**	0.4940
Organic dummy *Aug_2008	2.2807**	0.5590
Organic dummy *Sep_2008	2.3058**	0.4328
Organic dummy *Oct_2008	2.4356**	0.5077
Organic dummy *Nov_2008	2.6149**	0.5170
Organic dummy *Dec_2008	2.2510**	0.4468
Organic dummy *Jan_2009	3.1783**	0.6024
Organic dummy *Feb_2009	2.8075**	0.8336
Organic dummy *Mar_2009	3.1066**	0.5850
Organic dummy *Apr_2009	3.1889**	0.6577
Organic dummy *May_2009	2.9632**	0.6241
Organic dummy *Jun_2009	2.5777**	0.4446
Organic dummy *Jul_2009	2.2844**	0.4431
Organic dummy *Aug_2009	2.5176**	0.4721
Organic dummy *Sep_2009	2.3197**	0.4665
Organic dummy *Oct_2009	2.5775**	0.6115
Organic dummy *Nov_2009	2.7070**	0.5460
Organic dummy *Dec_2009	2.4132**	0.6443

Notes: **indicates statistical significance at the 5% level

Variables	Coefficient	Standard Error
Organic dummy *Jan_2010	2.6745**	0.6171
Organic dummy *Feb_2010	2.4016**	0.7307
Organic dummy *Mar_2010	2.5494**	0.4973
Organic dummy *Apr_2010	2.0660**	0.4087
Organic dummy *May_2010	2.4549**	0.4712
Organic dummy *Jun_2010	2.1913**	0.5093
Organic dummy *Jul_2010	2.1685**	0.4875
Organic dummy *Aug_2010	2.0850**	0.4152
Organic dummy *Sep_2010	1.9797**	0.4829
Organic dummy *Oct_2010	2.4724**	0.6012
Organic dummy *Nov_2010	2.1614**	0.5227
Organic dummy *Dec_2010	1.9779**	0.5137
Organic dummy *Jan_2011	1.4163**	0.4635
Organic dummy *Feb_2011	1.5228**	0.6176
Organic dummy *Mar_2011	1.7367**	0.4026
Organic dummy *Apr_2011	2.0418**	0.4238
Organic dummy *May_2011	2.1231**	0.4433
Organic dummy *Jun_2011	2.2151**	0.5060
Organic dummy *Jul_2011	2.3844**	0.5017
Organic dummy *Aug_2011	2.1959**	0.5779
Organic dummy *Sep_2011	2.2430**	0.5584
Organic dummy *Oct_2011	2.2454**	0.4557
Organic dummy *Nov_2011	2.2241**	0.5024
Organic dummy *Dec_2011	2.3380**	0.4647
Organic dummy *Jan_2012	3.8409**	0.5740
Organic dummy *Feb_2012	3.6778**	0.6017
Organic dummy *Mar_2012	3.8803**	0.6321
Organic dummy *Apr_2012	3.5953**	0.5965
Organic dummy *May_2012	3.3769**	0.8319
Organic dummy *Jun_2012	3.7893**	0.5758
Organic dummy *Jul_2012	3.1733**	0.5726
Organic dummy *Aug_2012	2.9499**	0.5333
Organic dummy *Sep_2012	2.9568**	0.5973
Organic dummy *Oct_2012	2.8530**	0.5823
Organic dummy *Nov_2012	2.8246**	0.5026
Organic dummy *Dec_2012	2.7968**	0.4938

Notes: **indicates statistical significance at the 5% level